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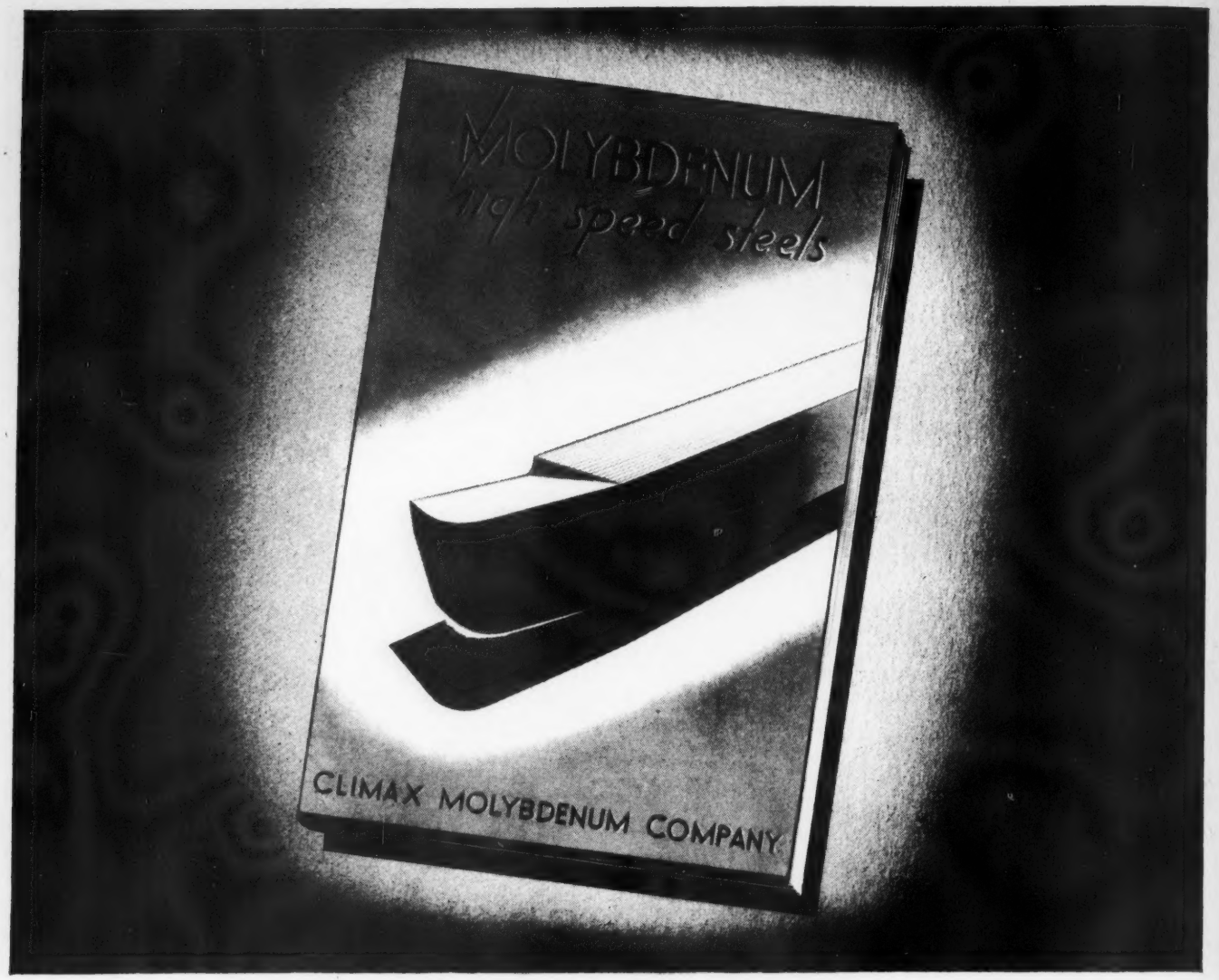

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DU PONT Digest
For Students of Science and Engineering

Research Program Produces Technique for Tapering Molten Nylon Bristles

Present state of development of the "spin-draw" machine evolved from the crude laboratory apparatus shown in the diagram below.

Difficult mechanical problems solved by Du Pont chemists and engineers to make nylon paintbrushes practicable

Nylon bristles used in toothbrushes and hairbrushes are uniform in diameter—that is, they are "level." But paintbrushes made from such bristles did not paint well. Studies of the best natural bristles showed that they were tapered, so a research program to produce tapered nylon bristles was started.

Some difficult mechanical problems were encountered. Level brush bristles were being made by extruding molten nylon through spinneret openings designed to produce filaments of perfectly uniform diameter. A new technique had to be found to make tapered ones. Since it was not practical to taper the filament after cooling and drawing, a precise taper had to be put in just as the nylon emerged molten from the spinneret. And it had to survive the drawing operation, in which nylon is stretched to several times its original length!

Techniques originated in laboratory

The original idea for solving this problem came from Du Pont chemists, who worked out the techniques in the laboratory, in the somewhat crude form represented in the accompanying diagram. It being largely a mechanical problem, chemical and mechanical engineers were called in to cooperate soon after the studies got under way. After further laboratory development, the engineers put the operation on a production basis.

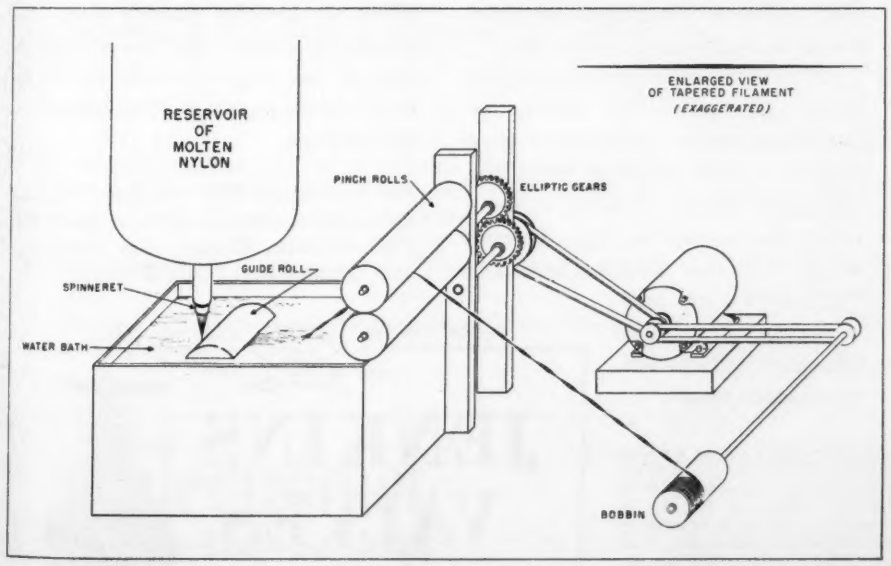
The final result was a highly efficient process for tapering nylon bristles. As the molten filament emerges from the spinneret, pinch-rolls driven by a series of gears pull it slowly, then quickly. The size of the filament varies with the speed of pulling—thick diameters resulting at slow speeds and thin diameters at fast. Next the nylon goes to the drawing operation, where it is stretched by rollers to give it strength and resiliency.

Engineers designed special machines

Following spinning and drawing, in which many filaments are handled simultaneously, the nylon is "set." Then it goes to a special machine, designed by Du Pont engineers, which "feels out" the crests and troughs and cuts the bristle at these points. This type of design was necessary because of the unavoidable small variations in the length of individual bristles. Sorting the bristles and sandpapering their ends completes the process.

Many techniques contributed to the development of the optimum properties of nylon in tapered bristles. At the laboratory stage, x-ray studies were made to learn the effect of various degrees of crystalization on bristle drawing and setting. Numerous devices were designed to test the bristles—for example, a machine that simulates the abrasive effect on a brush swept back and forth over a surface. Even after manufacture was established, high-speed stroboscopic photography and other stroboscopic studies were employed to improve coordination in the various operations and make a more uniform product.

The development of these bristles furnishes another striking example of the great variety of problems, often intricate, that may arise out of the discovery of a new substance like nylon.



Diagrammatic representation of the first laboratory apparatus used to establish the principle of making nylon from molten plastic. (From an early patent.)

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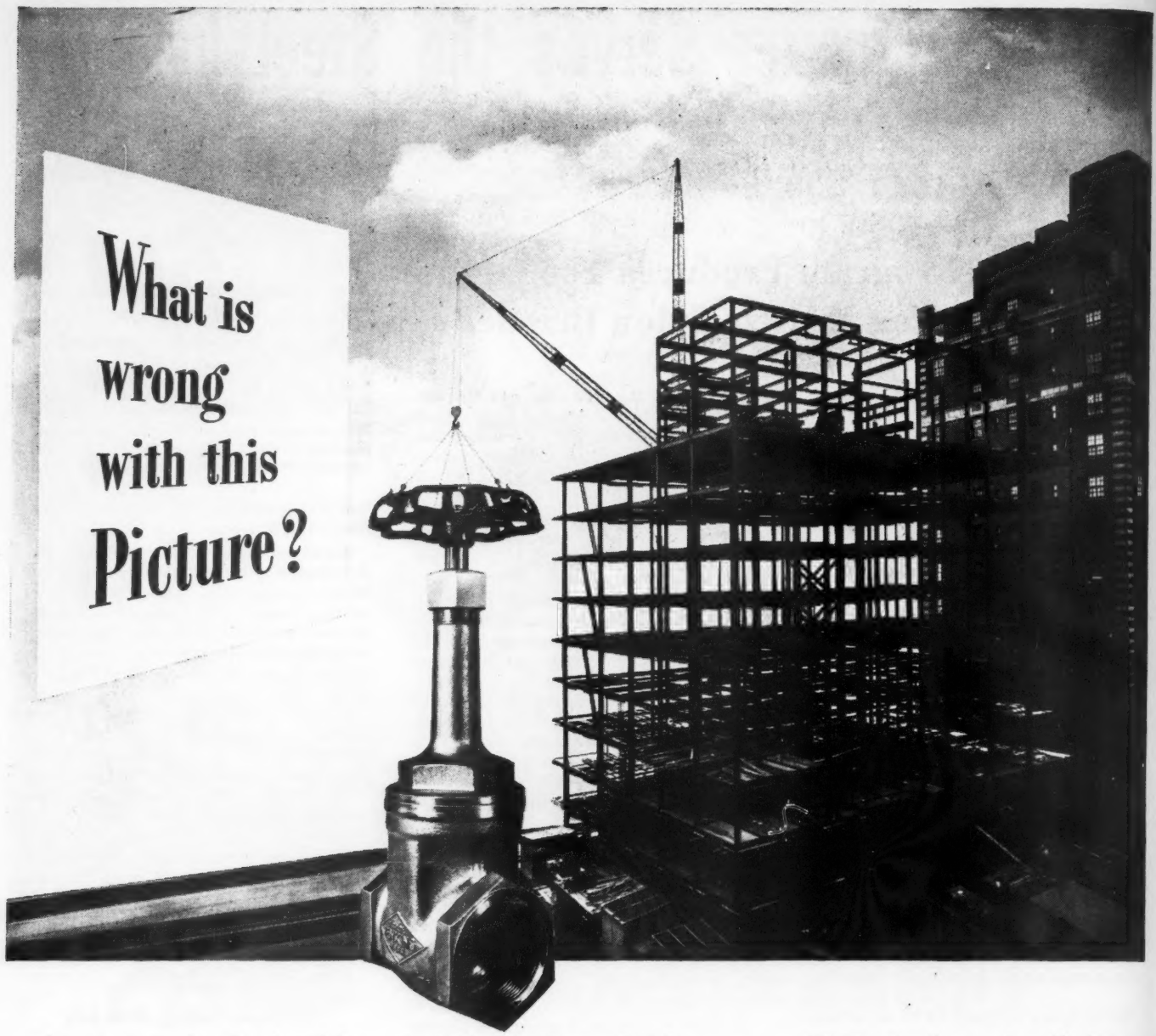

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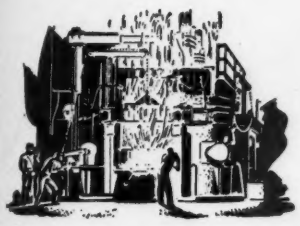

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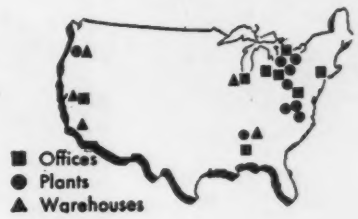

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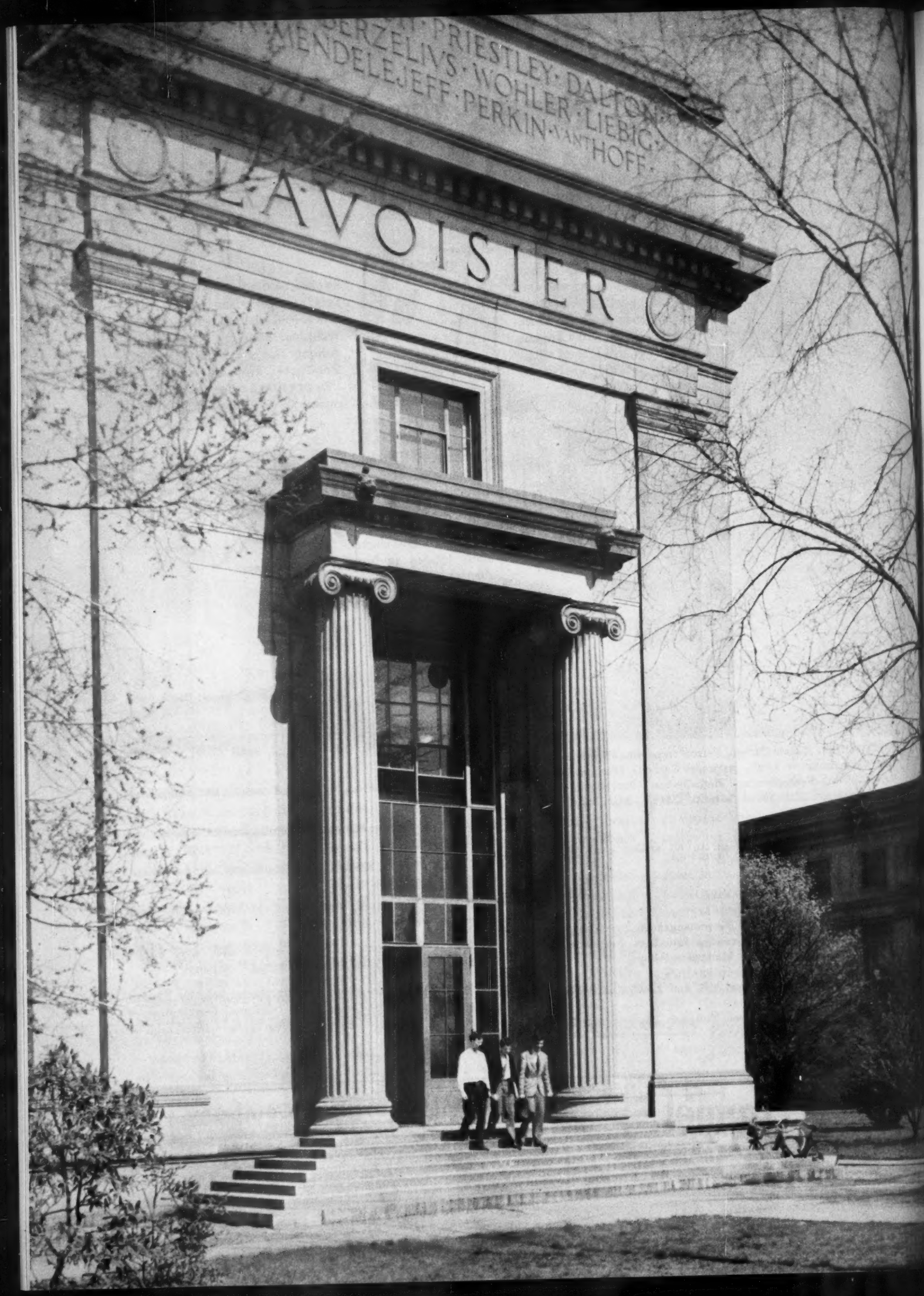
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the tech engineering news

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MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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from the editor's notebook

A native of New York State, **Robert J. Vidal** entered M. I. T. in June of 1946 after being discharged from the A. A. F. Bob joined the *T. E. N.* staff just three months ago in hopes of combining literary work with his Aeronautical studies. His first article, "Industry and Education," does not materially further this ambition, but it does serve to alleviate one of Bob's pet peeves — the fact that M. I. T. students know so little about their own school.

Last month **Harry Smith** wrote for the *T. E. N.* on the history of M. I. T. This month he delves even deeper into history with his article on the part of the earth's surface now known as the Atlantic Ocean. However, all this work has not drawn Harry's interest away from the scientific and technical training he came to Tech to obtain. He is still interested in a professional career somewhere between Mathematics and Electrical Engineering, but being a Freshman, he has decided that his literary efforts should be on non-technical matters. Of course, we are never prone to discourage any of our writers willing to turn in an article for two successive months.

Although still a Freshman here at M. I. T., **Irwin Manning** has an impressive record of attainment in the Electrical Engineering field. While still in Brooklyn Technical High School, he won a prize for the building of some electronic apparatus which would measure the deflection of a beam under a load. He has already spent several summers working as a draftsman for a firm engaged in designing and building F. M. broadcast transmitters and equipment. Here at Tech, Irwin's extra-curricula activities include, in addition to the *T. E. N.*, the Debating Society and the Walker Memorial Committee.

Ralph Johnston's name should be quite familiar to *T. E. N.* readers. With this last issue of Volume XXIX, Ralph's fourth article gets published. Ralph is getting to be a stand-by to us when it comes to getting tough assignments done. But this latest article on gas flow is right along his main line of interests. Ralph is studying Aeronautical Engineering here at Tech, and he has more than an idle curiosity about what is being done in the new Gas Turbine Lab. Now in his Sophomore year, Ralph came to M. I. T. from high school in his home city of New Kensington, Pennsylvania.

A while back **Alex Bloch** came into the *T. E. N.* office and asked if we were interested in publishing an article on his homeland, Palestine. We were more than pleased at the opportunity to have an article written on his country, for we were planning to have a series of articles on engineering developments in foreign countries, and Palestine was one of the countries we felt ought to be covered. Alex's home is in Tel-Aviv and it was only last fall that he left to come to M. I. T. Before that he went to the Herzlia Gymnasium, and after graduating from there, he studied in the British Institute of Engineering Technology in Jerusalem. He was able to enter Tech as a Sophomore in Mechanical Engineering, and at present plans to specialize in diesel engineering.

industry and education

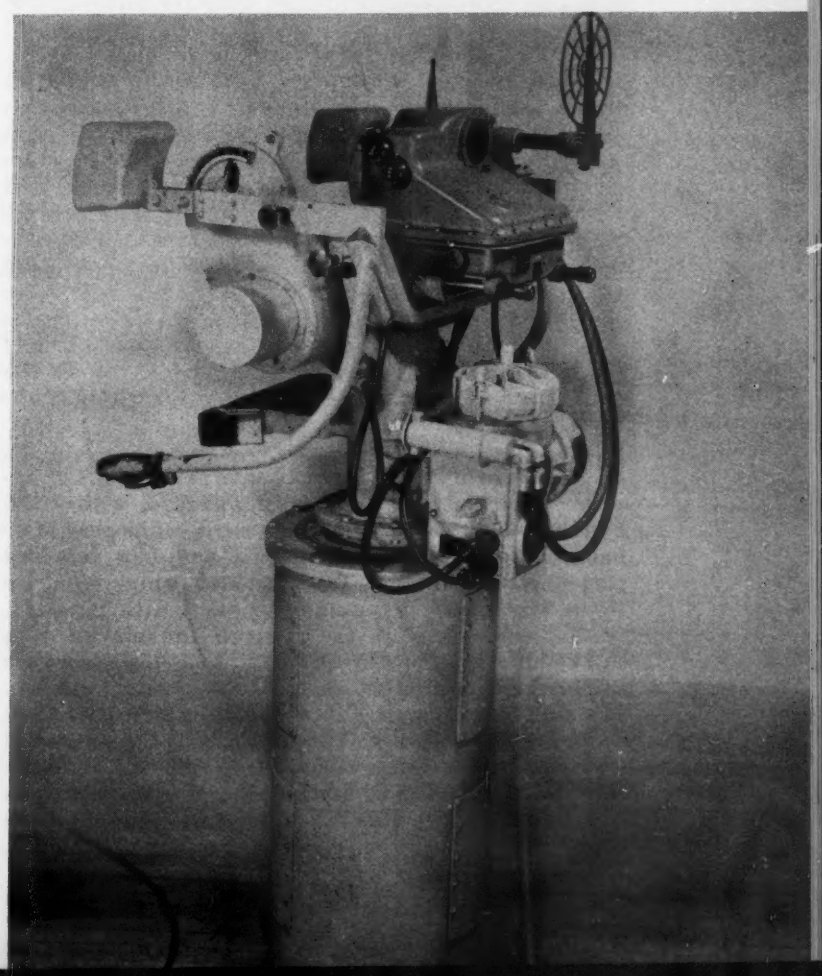
The Story of Tech's Division of Industrial Cooperation

By Robert J. Vidal, '49

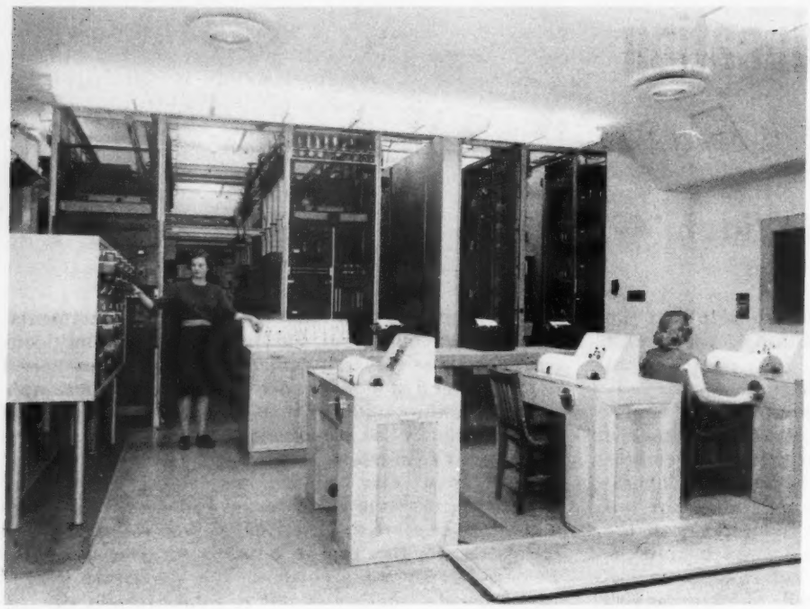
It is interesting, though startling, to note that the further one travels away from Cambridge, the greater is M. I. T.'s fame and reputation. Last month in an effort to help correct this paradoxical situation, M. I. T. invited local visitors to view our laboratories and equipment, hoping to acquaint both the community and the student body with some of the Institute's objectives and accomplishments. Thousands scanned the laboratories with their imposing array of apparatus, but few people were acquainted with what made many of the excellent facilities available. Tucked away behind the stories of electron accelerators, wind tunnels, microwave laboratories, and those hundreds of white mice in Building 20 is the tale of a single department which has been an important factor contributing to M. I. T.'s fame. Nearly all students know that this department — the Division of Industrial Cooperation — does exist, but few can explain why and how it exists.

In 1920 the Corporation voted to initiate a plan aimed at improving the available educational facilities, aiding the student in becoming a better scientist before gaining his degree, and diminishing the gap between education and experience. This plan, the Technology Plan, was based on the hope that industry was sufficiently interested in education to set up a five-year fund for pure scientific research. Industry was to be allowed to use our library facilities, the Student Placement Bureau, and other minor facilities, but the crux of the matter was that industry was asked to set up a fund and in return was assured nothing more concrete than the possibility that the laboratories might unearth some new and useful theories. The idea behind the plan was to stimulate an interest in M. I. T. so that companies would bring certain types of problems here for solution, thus bringing education and industry closer together. There is little question as to the success of the plan since at the end of the first five-year period a second five-year fund was set up. At the end of the second five-year period, the original plan evolved simply into the present Division of Industrial Cooperation, and funds were no longer solicited. Under the present plan, companies come to M. I. T. with problems which cannot be solved with their own facilities, and the Institue contracts to delve into those phases of research which are deemed desirable. The D. I. C.'s success is illustrated by two facts. The most flattering fact is that other colleges have since started similar plans. The most material fact is that the D. I. C. began virtually with just an office, a stenographer, and a typewriter, and today can boast sixteen hundred employees and an anticipated twelve million dollar income for this year.

Many people have been lead to believe that the D. I. C. is a separate department and must therefore act independently of the educational departments. This is a misconception, for the division can only contract for those research projects which are sanctioned by the educational departments. A simplified example of the procedure followed in arranging for a project will help to clarify any misconceptions concerning the department's functions. Suppose the D. I. C. received a letter from some company explaining the type of research in which it is interested and asking that such a program be started. The D. I. C. would then forward the letter to the proper department — perhaps the Physics Department — where the department head would decide whether or not it would benefit his students. If it were decided that the program would aid his students, the department head would then draw up a tentative plan for the program and submit this plan, along with the company's original proposals, to the Dean of Science. If the dean found the program and plan acceptable, he would approve the project and refer it back to the D. I. C. The division would then go through the necessary business formalities and arrange the details. In short, the D. I. C. functions as an agency to screen the educational departments from the task of contending with the time-consuming formalities of establishing and maintaining contacts with industry, and provides industry with a very convenient central office to which it may beam its inquiries.



The Mark 14 gunsight developed by Technology and the Sperry Gyroscope Company, Inc., mounted on a Sperry Mark 51 gun director *Technology Review*



During the war this 100-ton differential analyzer calculating machine built under the D. I. C. worked on important war projects, including trajectory calculations for the United States Navy. Nearly 200 miles of wire, 150 motors, 2,000 electronic tubes, and thousands of relays are contained in this huge labor-saving device.

The word cooperation in the division's title is appropriate to say the least. The department is in the unique and unenviable position of having to maintain a good relationship with industry and still having to refuse many projects which are presented to it. Some companies contact the D. I. C. with the thought in mind that the Institute will carry out any project that the company finds inconvenient to pursue. Such projects as routine but lengthy chemical analyses, stress analyses, and similar development projects are politely refused, and the cooperation then comes into play with the D. I. C. referring the company to commercial establishments. The policy is that the Institute is not in competition with any industry and will not accept any projects which could be adequately handled by existing and convenient companies. Past cooperation has been such that many companies now contact the D. I. C. in order to find out what other companies exist which can fill their particular needs. The division naturally receives the usual quota of perpetual motion machines, but the inventors are politely informed that both the D. I. C. and the Institute firmly believe in the Second Law of Thermodynamics. A lengthy correspondence was once carried on with a high school student who was writing an English paper on some romantic phase of Aeronautics. After several attempts were made to assure the student that the division could not help him, the division was finally able to pass the buck by referring him to the *Popular Science* volumes in his local library.

As students, you are primarily interested in how the D. I. C. benefits the student body. The D. I. C. employees can be broken down into groups, with seven hundred non-staff or administrative employees, five hundred full-time staff members, and four hundred part-time employees. The non-staff employees are those who aid in maintaining contact with industry, the full-time staff are the research workers hired to carry out parts of the projects, and the part-time employees are instructors, professors, and students. The staff members are able to work on industrial projects at industrial wages and still pursue one course of study at the Institute. Thus they are substantially able to have their cake and eat it too. The professors and instructors are able to work on industrial projects and keep their courses more on a level comparable with what industry requires.

Those students working on D. I. C. projects are seniors and graduate students. Twenty per cent of M. I. T.'s graduate students are actively engaged in D. I. C. work, so it is obvious that the D. I. C. does directly benefit a large number of students. When a student is planning his thesis work, he may find a division project which interests him and which covers his phase of research. If this is the case, the student can work on a thesis problem which would be found in industry, and at the same time receive his thesis credit and earn a salary. An interesting example of students combining thesis work with a D. I. C. project was brought up recently when a professor remarked that one project had yielded fourteen theses covering different phases of the total program. This surprised the D. I. C. officials because they regarded that particular program as one of the minor ones being pursued.

For the enlightenment of those students who object to having professors with interests in both educational and research work, microwave research can be brought into the limelight. Instructors and professors devoted their energies to education and radar research several years ago, and as a result the Armed Forces were given a valuable weapon, while today the M. I. T. students are able to study some of the best available courses covering microwave work. This may appear to be an isolated example, but similar examples can be drawn from nearly all Institute departments.

It would be foolish to think that industry does not benefit from D. I. C. projects. The mere fact that the companies do come here in an effort to arrive at solutions to problems makes it obvious that they do gain from the projects. Probably the most appealing factor to the companies is the fact that M. I. T. represents an accumulation of scientists and laboratories that no corporation could afford to hire. It might be argued that because M. I. T. does represent such an accumulation, scientists who plan on working exclusively for industry find their futures endangered. There are enough inherent faults in the system, however, to prevent companies from coming to depend entirely on college facilities and do away with their own research laboratories.

The D. I. C. projects successfully completed are far too numerous to even name, but their importance can be illustrated by using one as an example. Many veterans here at the Institute remember the Mark 14 gunsight manufactured during the war by the Sperry Gyroscope Company and will gladly expound on the gunsight's merits. With this apparatus, American gunners were able to automatically make allowances for lead, drift, and gravity effects when firing on enemy aircraft. This gunsight, developed under the direction of Professor J. S. Newell of the Aeronautics Department, was undoubtedly a large contribution towards American Naval superiority in the Pacific, and it can safely be said that many Japanese found the gunsight's uncanny accuracy most disconcerting.

Many of the present D. I. C. projects are now housed in Building 20, and the research programs range from Linear Electron Accelerators to test on white mice in order to ascertain the effects of vitamin deficiencies. Again a long list of imposing names could be given in order to impress you with what is being done, but one specific example will prove more interesting.

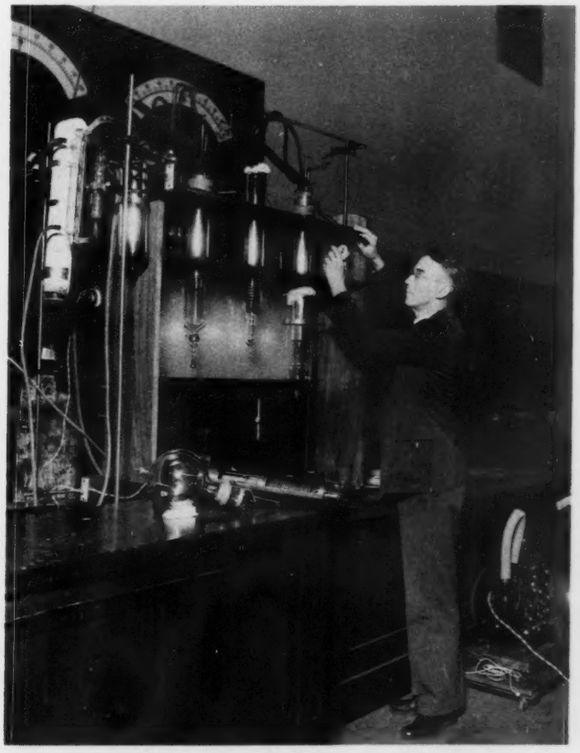
If you were to walk through one of the most remote corridors in Building 20, you might come across a room filled with apparatus and emitting the sounds characteristic of an old, tired-out steam engine. Upon further investigation you would find that the room housed a Cryostat used in making liquid helium and that the apparatus was used in low temperature experiments. This experimentation is being carried out as pure research to find out what happens to matter at low temperatures and to find plausible explanations for some of the phenomena encountered. Lead has been one of the materials used for experimentation and has exhibited some very interesting characteristics. At room temperatures, lead is considered to be a poor electrical conductor. As the lead is cooled, it loses some of its resistance, but at 9° Kelvin it still displays a measureable amount of resistance. When cooled to 8° Kelvin, the lead suddenly loses all electrical resistance and becomes a super-conductor. If a current were begun in a loop of supercooled lead, this current would continue for an indefinite length of time after the electrical source had been removed. The scientists have not been able to account for this strange behavior but believe that it may be tied in with the fact that at or near 8° Kelvin, the molecular structure of lead changes from a disorderly arrangement to an orderly arrangement. The lead used in these experiments must be absolutely free from impurities or else the phenomena described will not take place.

Supercooled helium displays some equally strange properties when it reaches a particular temperature. The gas liquefies to Helium I at 5° Kelvin and exhibits the properties usually associated with a very cold liquid. If it is then cooled further and allowed to boil back up to 4° Kelvin, liquid Helium II and its confounding physical properties are the result. There is little or no viscosity displayed, and several impressive experiments can be made. For example, the helium fountain is easily set up and consists simply of some Helium II and an extremely thin capillary tube. When the tube is placed in the helium, the liquid will shoot up and out of the tube. It is a little difficult to handle Helium II for if a container of it is placed within another container of the liquid with one liquid level below the other,

(*Continued on page 338*)

Technology News Service

Collins Helium Cryostat, low-temperature-producing device, shown with Dr. H. O. McMahon of Arthur D. Little, Inc.



Oxygen and hydrogen were converted into solids in this low temperature apparatus during a lecture by Dr. Frederick G. Keyes, shown dismantling his devices after the lecture.

dead land of the deep

Harry F. Smith, Jr., '51

If one could check through all those writings of antiquity which are still extant on earth today, he would find a few, rare references of fair trustworthiness to a land which once occupied the Atlantic Ocean of today and at some time many centuries ago vanished into the sea in some terrible cataclysm. The most reliable and the most lucid of these references would be the one by Plato, Greek writer and philosopher of the fourth century B. C. His story, contained in portions of two of his dialogues, is as follows:

Solon, a lawgiver of the ancient Athenians, went to Egypt for the purpose of self-enlightenment. In the Nile River town of Sais, an Egyptian priest gave him his first knowledge of a former empire far to the west. This country, called Atlantis, consisted of a fertile, central plain surrounded by a ring of mountains which warded off the icy winds of the north. The people of this nation had once embarked upon a conquering expedition among the Mediterranean peoples and had been halted only at the last moment, but then decisively, by the gallant Athenians. It was just about at this moment of defeat that great earthquake, volcanic, and tidal action plunged the homeland of the invaders beneath the ocean. All of this happened about 9600 B.C.

The complete story is more elaborate than that — too much so, for it mentions the actions of the Greek gods in connection with Atlantis and, in addition, describes this western empire as being generally Utopian in character. These points are pretty obviously inaccuracies; on the other hand, evidence is accumulating constantly which has shown first the possibility and now the definite probability of just such a land mass as Plato recounts.

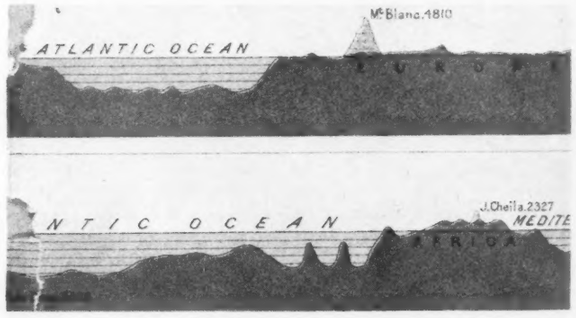
Geologists have found that the region which is now the Atlantic Ocean was once occupied by two continents. In the northern area was a mass of land comprising Russia, Scandinavia, Great Britain, Greenland, and Canada and to which was later added huge portions of present-day Europe and the United States.

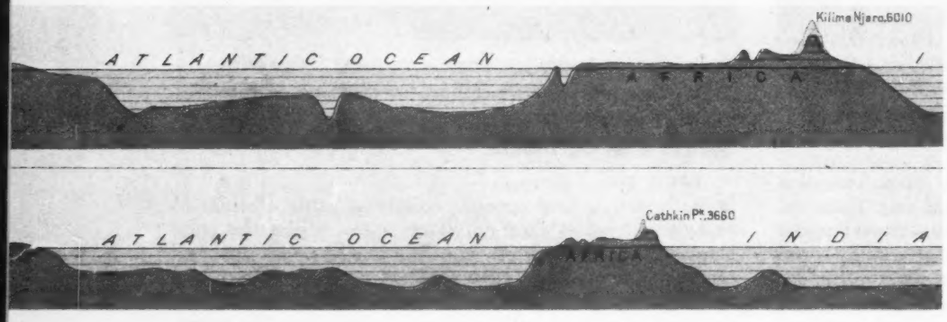
This northern continent was separated from the southern one by what is known as the "mediterranean depression," which is a deep ring around the earth's middle dating from the beginning of geologic time — still evident in the Mediterranean, Caribbean, and Sunda Seas. In a period of instability extending to the end of the Tertiary Period, or when man first appeared, these continents began to break up and slip into the ocean, with three consequences.

First, the mediterranean depression, or sea, separating the continents was widened and subdivided. Next, volcanoes, particularly those in the active region of the eastern Atlantic, went into activity, because the collapse of all this land squeezed lava from the earth's interior. Finally, great wrinkles and folds were made in the earth's surface, the result being today's Alpine chain, which stretches from northern Italy and Switzerland across southern France and Spain as far as the ocean. This Alpine chain seems to have been continued further westward at one time. If this really was the case, one branch would pass through the Azores and another would touch the Canaries. It can be stated from examination of sediments in the southern Azores that a large island or continent extended from its shores there at a time recent on the geologic scale. Scientists have found, also, that this mobility of the Atlantic Ocean floor has continued up to the present, with evidence existing of certain movements near the African shore.

The cause of these vast movements, while unknown, can be guessed at. Possibly the melting of the ice caps of the Ice Ages, resulting in a raising of the sea level and a compression of the land beneath the ice, is a fundamental activator. Indeed, this great melting process might also have resulted in a period of extended precipitation, as a counteractant to excessive thawing, which would be the "great flood" referred to in the Bible and other sources.

Let us now see what kind of case we can assemble





These are cross-sectional diagrams of the bottom of the Atlantic Ocean as it now appears. The two above, reading up, were taken respectively at 35° North and 50° North; while the two at the left, reading down, were taken respectively at the Equator and 30° South.

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for the actual existence of Atlantis. In the years 1872–1876, the United States, Great Britain, and Germany carried out a joint project of sounding the bottom of the Atlantic. Their motives were primarily the securing of oceanic cable-laying data and only secondarily the acquisition of scientific knowledge. Five ships, systematically mapping zone after zone, found that a huge "mountain chain" runs north-south through the Atlantic exactly where Plato placed Atlantis. This chain, which is called the Dolphin Ridge and which follows the general trend of the Spanish and African coasts, is not the only prominent feature. Just below the Azores is the Challenger Ridge, running east-southeast from the northeastern shores of South America to the coast of Africa and then turning due south, continuing all of the way into the South Atlantic as far as Tristan da Cunha.

Perhaps the most irrefutable proof is that offered by a ship employed in laying submarine telegraphic cable five hundred miles north of the Azores in 1898. The crew was trying to locate with grappling hooks a strand which they had temporarily "lost" two miles down. Considerable difficulty presented itself because of the jagged, rocky character of the ocean bottom, and bits of matter had to be constantly removed from the implements. These same particles of matter were found on microscopic examination to be lava, lava which must have solidified in the open atmosphere because of its vitreous structure (scientists had learned that lava solidifying under water assumed a crystalline structure). Since, in addition, lava decomposes considerably in fifteen thousand years, the area below must have been above the water within that period; this comes well within the period of man's advent on earth, even though humans have occupied the planet for only 1/2500 of geologic time.

The possibility of land masses rising from and submerging into the ocean depths still is not only likely but proven — most spectacularly, perhaps, in the case of the astronomers who decided to observe an eclipse from Sarah Ann Island. When their equipment-laden ship arrived at the site of the island, it was no longer there. It would, after all, take but a slight warping of the earth's crust, as much as 1/8000 of its diameter, to raise the Dolphin Ridge above the surface of the water or to plunge it beneath once again.

Consider next the facts concerning the Gulf Stream. Here we have a river within an ocean — a warm current that makes Great Britain, eastern Europe, and southern Scandinavia quite livable, while regions of the same latitude in America are bitter cold. This current, which was the factor that opened the way for the spread of civilization from Mediterranean regions to northern Europe, could not have existed at a time when a continent was set in the middle of the Atlantic; but, then again, what started it to begin with?, for it is a scientific axiom that there is a cause for every effect. Does it not seem reasonable to believe that the ruinous end of this continent, accompanied by volcanic action and heat practically unequalled in human memory, might have started the swirl of waters that today is the Gulf Stream?

Such is the combined testimony of geology and oceanography. Other sciences, particularly anthropology and ethnology, have a tale that is just as convincing. Take, for instance, the case of the Cro-Magnon man. In a restricted area of southwestern Europe have been found the remains of a remarkable human race and its handiwork. Declared to be the finest example of man, both mentally and physically,

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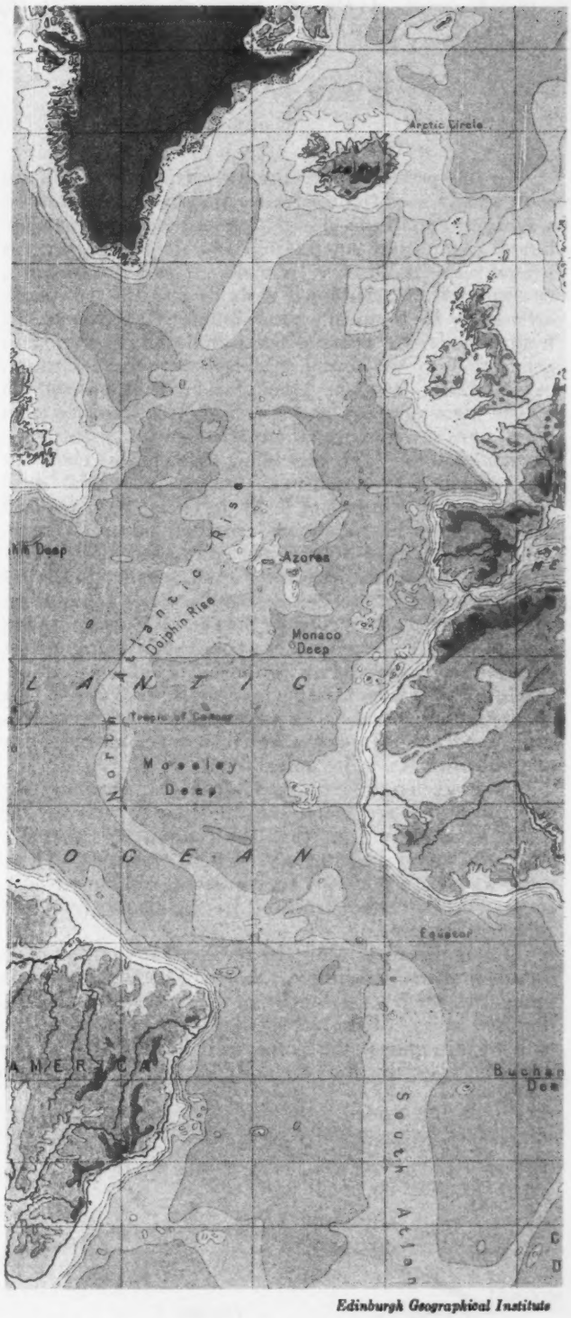

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A map of the Atlantic Ocean indicating depths. Note the North Atlantic Rise running through the center

f. m.—new developments

A New Possibility for Dependable Trans-Atlantic Broadcasting

Irwin Manning, '51

At the present time, the two systems which are most widely used to broadcast sound by means of radio waves are amplitude modulation and frequency modulation. Amplitude modulation (A. M.) is the process whereby the radio wave is made to vary in strength, or amplitude, in accordance with the transmitted speech or music. In frequency modulation (F. M.) it is the frequency of the transmitted signal that is varied in proportion to the sound intelligence to be communicated. Using frequency modulation, it is possible to realize higher fidelity and much greater freedom from noise and interference than is achieved with A.M. transmission. F. M. is now being used commercially for short-distance broadcasting. Due to technical difficulties, the advantages of F. M. have not been realized in extremely long-distance communication. Trans-Atlantic transmission of speech has been notoriously unreliable on A. M., and yet F. M. seemed to offer no improvement. However, recent research, conducted here at M. I. T. by Professor Lawrence B. Arguimbau and Mr. John Granlund, has uncovered important information which gives promise of making trans-Atlantic F. M. broadcasting commercially feasible. An understanding of these discoveries requires a knowledge of certain phenomena which have been well known to radio men for quite some time.

The wavelengths that modern F. M. broadcasting stations utilize are much shorter than those used for A. M. broadcasting, so that the radio waves actually behave in much the same way as light waves do. These radio waves are not bent very greatly, and, as a result, such a station cannot transmit its signals much farther than the horizon.

If long distances are to be covered, advantage must be taken of the ionosphere, a layer of ionized air enveloping the earth at a height of some seventy to two-hundred miles. If the wavelength of a radio wave lies in a certain range, the wave will be reflected by the ionosphere and by the earth. It is thereby possible to have this wave propagated in the manner illustrated in Figure 1.

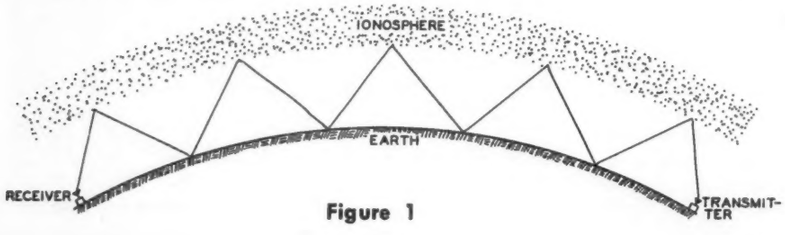


Figure 1

It usually happens that more than one wave travels from the transmitting to the receiving point. Such a situation is depicted in Figure 2, where the length of path of wave A is less than that of wave B. Since the distance traversed by wave A is shorter, a given point on wave A will arrive at the receiving antenna before the corresponding point on wave B. This time lag is illustrated by the curve of Figure 3. The successful long-distance F. M. receiver must choose only one of these waves and act as though the other were not present. Previous to Professor Arguimbau's investigations, this receiver design objective had never been achieved.

The investigation of these phenomena required the setting up of a laboratory experiment which reproduced the actual conditions encountered in ionosphere transmissions (Figure 4). This apparatus is similar to that used for Radar research. A test signal was sent simultaneously through a mercury column and an attenuator. Since the signal travelled faster through the attenuator than through the mercury column, there was a time delay between the arrivals of the two signals at the receiver. The amount of this time delay was controlled by varying the length of the mercury column.

Referring again to Figure 3, the frequencies of the two signals of waves A and B can be considered to

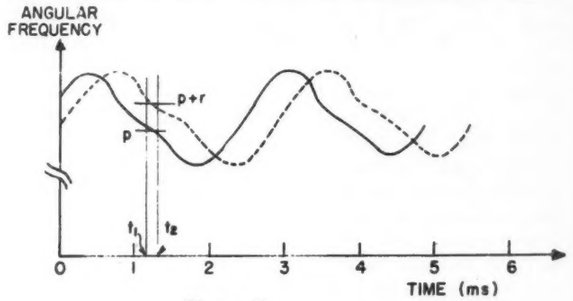


Figure 3

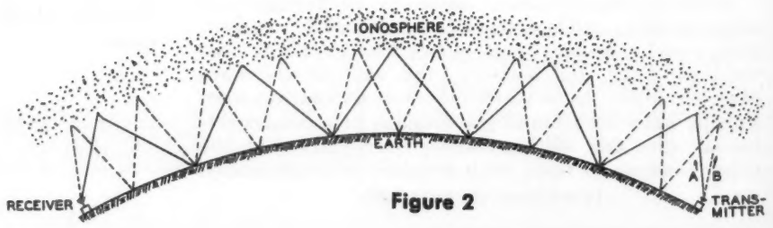


Figure 2

remain constant over a period of time t_2-t_1. A vector diagram can then be constructed which shows the instantaneous relation between the two signals (Figure 5). In the most undesirable case, the voltage produced by one signal is almost equal to the voltage produced by the other. If the stronger voltage is drawn as a unit vector, then the weaker voltage, $\vec{a}$, is slightly less than 1, and the vector triangle is approximately isosceles. From this it follows that $\theta \cong \frac{1}{2}rt$. The angular frequency of the resultant is:

$$\omega = \frac{d\phi}{dt} = \frac{d(\theta+pt)}{dt} \cong \frac{d(\frac{1}{2}rt+pt)}{dt} \cong p+\frac{r}{2}$$

However, since the resultant vector never differs from the unit vector by more than 90°, the frequency of the resultant averaged over a large period of time (say, several cycles) must equal the average frequency of the stronger signal which is $\bar{\omega}=p$. This situation can be visualized more easily by imagining vector $\vec{a}$ to be continually rotating about the end of the unit vector at the same time that this unit vector is rotating about the origin.

The analysis so far shows that the time average of the resultant frequency is equal to p, but over most of the cycle, the instantaneous resultant frequency is nearly equal to $p+\frac{r}{2}$. This apparent discrepancy is explained by the fact that the resultant frequency drops abruptly to a value which is much less than p for a small part of the cycle. When angle rt is nearly equal to π radians, the previous mathematical analysis fails,

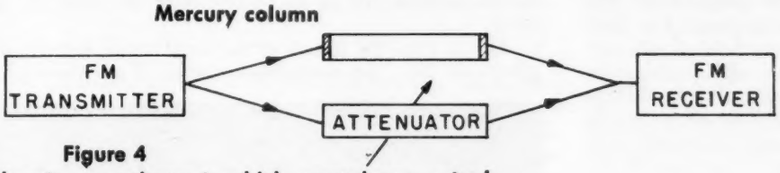


Figure 4

Laboratory equipment which reproduces actual conditions encountered in ionosphere

since the vector triangle is no longer isosceles. In this case the resultant frequency is:

$$\omega \cong p-\frac{ar}{1-a}$$

This situation is depicted in Figure 6, where the instantaneous resultant frequency is plotted as a function of time. The dotted curve illustrates the case where $\vec{a}$ is slightly greater than one.

Figure 7 is a functional block diagram of the simplest conventional F. M. receiver. The signal is picked up by the antenna and magnified by the amplifier. Good results are achieved only when the variations of the amplitude of this signal are eliminated. A limiter irons out these fluctuations, thereby producing a signal of constant amplitude. The discriminator is the heart of the receiver. It produces an audio signal whose instantaneous amplitude varies in proportion to the frequency variations of the transmitted F. M. signal. That is to say, the instantaneous variations of the discriminator output are identical to those of the speech or music which was transmitted. The discriminator output is amplified and fed into the loudspeaker.

The range of frequency variations used in commercial F. M. broadcasting is ± 75 kilocycles. The conventional receiver is therefore designed to admit a range of frequencies which is within ± 75 kilocycles of the dial setting. In other words, the selective circuits of the radio frequency portion of the receiver are built to have a pass band of 150 kilocycles. This type of receiver works well when one signal predominates strongly. However, when two signals of nearly equal strength are impressed upon the receiver, an inordinately large amount of distortion takes place. It was this effect which retarded the development of long-distance F. M. broadcasting.

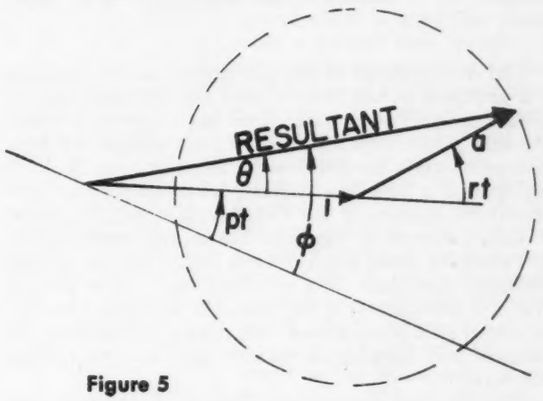


Figure 5

Vector diagram showing the instantaneous relation between the two signals received from the transmitter in long distance "skipping" F.M. transmission

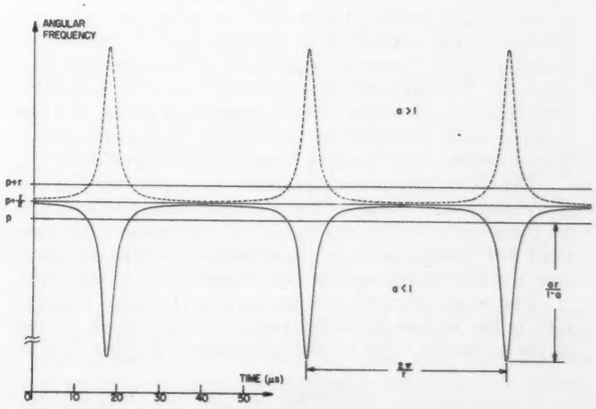


Figure 6

Plot of instantaneous resultant frequency for the previous diagram

Experimentation proved that the distortion did not develop in the radio-frequency amplifier, but did take place in the limiter. The explanation of this effect is rather complex, and centers around the fact that, in the case of two signals, the frequency of the limiter

(*Continued on page 346*)

basic research in gas flow

The Gas Turbine Laboratory at M. I. T.

Ralph C. Johnston, '50

The development of the gas turbine to the position of a practical power source, and the advancement of aircraft speeds to the sonic level have opened a whole new field of investigation, that of compressible air flow. In order to study the problems of this new field, M. I. T. has opened a new gas turbine laboratory. The new laboratory, dedicated last October, is really the result of plans initiated at the Institute as long ago as 1942. At that time, some research was begun on gas turbine problems, and plans for a new laboratory were formed. The new laboratory, made possible through generous industrial gifts, is equipped with unequaled facilities for research and instruction in the field of gas turbine problems.

Despite the name *Gas Turbine Laboratory*, gas turbines as operational units are not studied in the laboratory. It was decided from the beginning that the purpose of the laboratory would be to provide facilities for graduate study and research of a type which would complement rather than compete with industrial research. In addition to instruction, the objectives of the laboratory are to acquaint the staff with the problems encountered in the field of gas turbines, and to extend the boundaries of knowledge in this field by means of long-range research intended to discover basic principles rather than to develop specific apparatus. By investigating problems of a broad scope, the laboratory will be able to contribute information to many fields.

The gas turbine is unique among power plants for two reasons. First, a gas turbine requires a high degree of refinement before it can operate with any practical efficiency, and second, it is composed of distinct components which are easily separated for individual investigation. The laboratory is intended to study the basic principles of operation of the component parts of a gas turbine with the aim of perfecting each component. Development and "testing" work is to be avoided.

The three major components of a gas turbine are the compressor, combustion chamber, and turbine, and all three units will be studied at the laboratory. Because fluid flow problems are of prime importance in all three, much of the initial work of the laboratory is in this field.

The main research tool in the Gas Turbine Laboratory is the supersonic wind tunnel. The tunnel, shown in the cutaway view of the laboratory, Figure 2, is of a conventional closed-circuit, steady flow type with a Mach number of three and a test section of sixty-four square inches cross-sectional area. As can be seen in the drawing, the main part of the tunnel circuit is in a vertical plane. The necessary pressure drop for supersonic flow in the test section is maintained by a five stage centrifugal compressor, driven by a 1350 h.p. variable speed d.c. motor which obtains its power from a motor-generator unit. Both the compressor drive motor and the generator of the motor-generator unit are war surplus submarine engines. To obtain ideal test conditions, the specific humidity of the air in the tunnel can be kept as low as three parts water vapor per 10,000 parts air by weight by the use of a dual-absorber type activated alumina air dryer. The range of tunnel reservoir pressures and temperatures is from two-tenths to two atmospheres and from 80° F. to 120° F. Lowering of the tunnel operating pressure is achieved by the use of ejectors, and the increase of tunnel pressure is accomplished by the induction of air on the suction side of the compressor through the air dryer.

Let us trace the action of the air through the circuit. After exit from the compressor the air flows through a

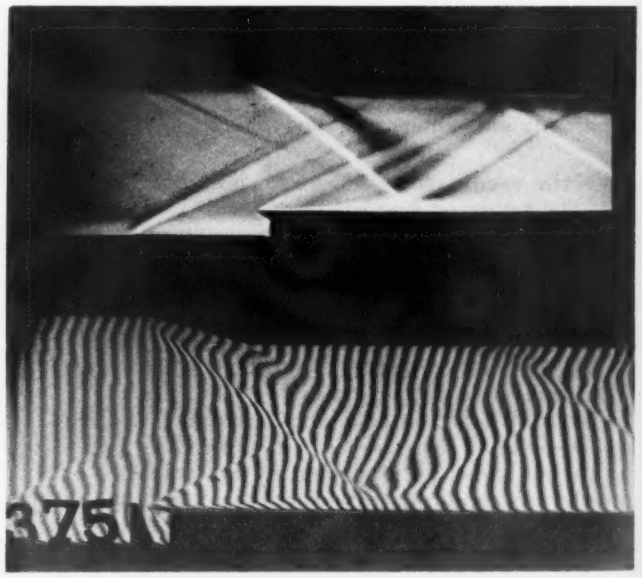


Figure 1 above shows two pictures of a shock wave pattern produced by a knife-edge inserted in a supersonic air stream. The top picture is taken with a schlieren apparatus, and the bottom picture by the interferometer.

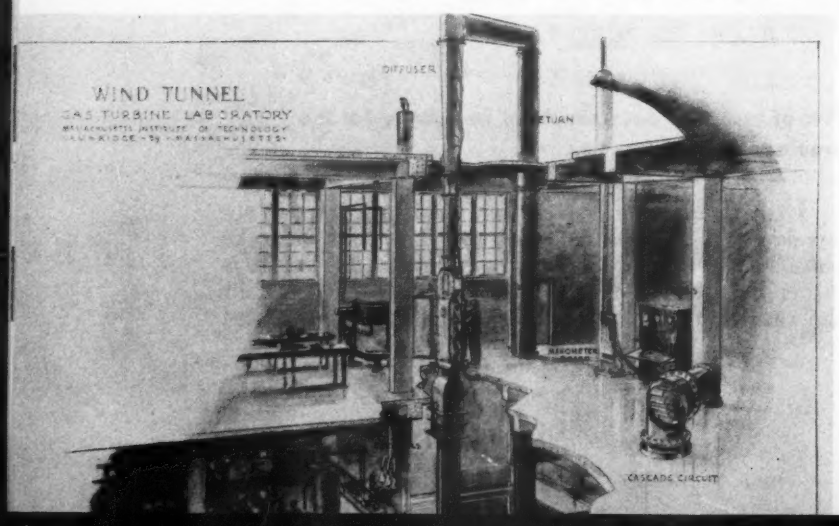
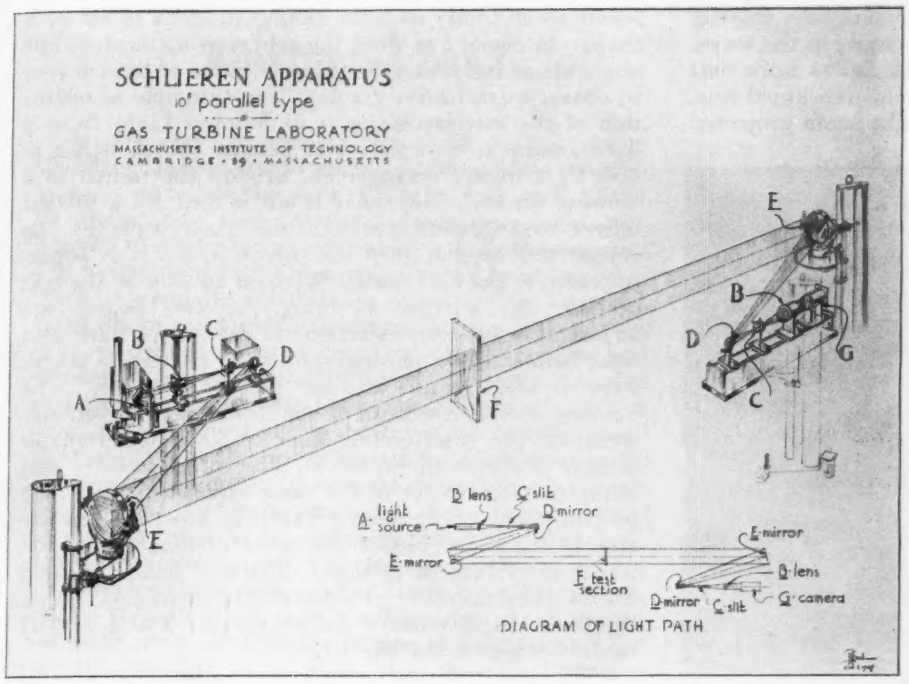


Figure 2, to the left, a cutaway view of the gas turbine laboratory

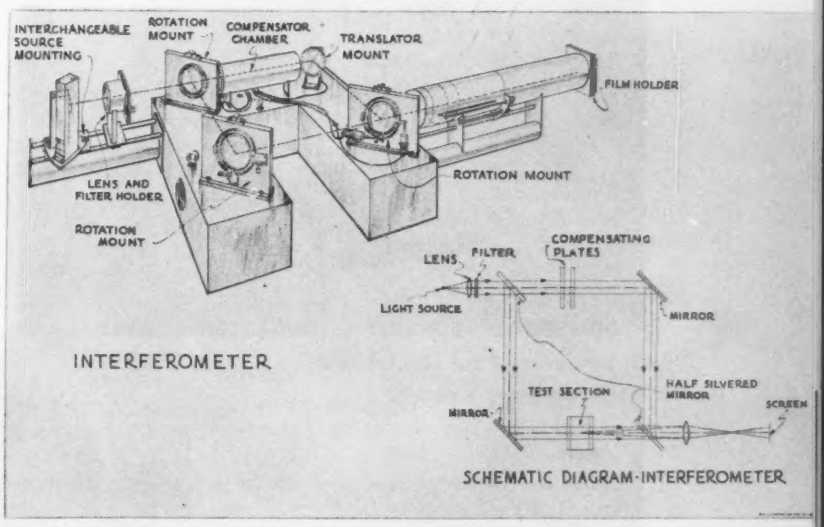


water-cooled, aircraft type heat exchanger. Temperature control is maintained by means of a control valve on the cooling water supply. Before entering the supersonic nozzle, the air passes through seven screens for the removal of turbulence. At the entrance to the supersonic nozzle, the air is at a temperature of about 100° F., and is travelling with the low speed of 100 feet per second. As the air passes through the nozzle, it picks up speed to Mach one, and the temperature drops to 6° F. After the velocity of sound is reached, the channel diverges and the velocity increases, a characteristic of compressible flow opposite to the behavior of incompressible flow. At the test section point, the air reaches a velocity of Mach two and the temperature is down to −150° F. Beyond the test section, the air flows into a diverging pipe in which it is brought to a higher pressure and thence returned to the compressor at low velocity. This diffusion or pressure recovery process determines the power requirements of the compressor.

Complete control of the supersonic wind tunnel is possible from a central control panel. By varying the compressor speed it is possible to control the volume delivered by the compressor and match the compressor ratio with nozzle pressure drop. A system of remote control valves, a system of thermocouples which measure the temperature at points in the tunnel, and a system of pressure taps along the diffusor connected to a manometer board beside the control panel combine to give the operator a complete picture of what is happening to the air in the tunnel at various points. By regulating the flow of air into the tunnel through the dryers or out of the tunnel through the ejectors, the operator can change the operating pressure in the tunnel without stopping the system.

In the cutaway view of the laboratory the reader will notice that at the point where flow starts up toward the test section of the supersonic tunnel there is a bypass junction with a second flow circuit. This second flow circuit is for the future installation of a high speed cascade test unit. The cascade apparatus will furnish a means of studying the nature of air flow around mounted turbine or compressor blades at air speeds up to Mach one and one-half. The test section of the completed cascade apparatus will be forty-five square inches in area, allowing the mounting of about seven blades. The approach velocity of the cascade circuit can be either sub- or supersonic. The bypass arrangement will allow the main compressor to furnish air for either the supersonic tunnel or the cascade apparatus.

Because a literature survey of cascade investigations has shown a lack of knowledge pertaining to the design and use of a cascade test apparatus, the circuit may be used to study the method of testing airfoils in a cascade rather than to obtain design data from the cascade measurements. At the present time the laboratory is experimenting with a low speed wooden cascade tunnel in order to gain information necessary for the design of the permanent cascade apparatus.



To provide air for combustion studies, the laboratory is equipped with a relatively small piston type compressor which can deliver seven pounds of air a second at an absolute pressure of fifty pounds per square inch.

In addition to the investigation of the principles of component operation the laboratory has as an objective the study of methods of instrumentation and measurement. Of prime importance is the problem of analyzing high-speed flow phenomena both qualitatively and quantitatively. Obviously, no instruments can be

placed in an air stream under investigation, for such instruments would alter existing conditions. Because of such limitations, the two principal instruments used for flow visualization are optical in principle. The first instrument, a schlieren apparatus, makes use of the change in the refractive index of air with change in density. When a shock wave occurs in a rapidly moving air stream, a sharp pressure change occurs in the wave, and the index of the air in the shock differs from that of the air outside the shock. The schlieren apparatus, shown in schematic above, uses a light beam projected through the air stream onto a screen to visualize the shock waves. Figure 1 shows a schlieren photograph of shock waves. Schlieren pictures are useful for a qualitative analysis of high speed phenomena. The other optical instrument is the Mach-Zehnder interferometer, a schematic diagram of which is also shown. The interferometer not only uses the change in index of air with change in density as does the schlieren apparatus, but also utilizes the principle of interference of light waves to obtain quantitative results. The principle of operation of the interferometer is as follows: Light from a light source is split into two beams, one of which is sent by a mirror arrangement around the tunnel to a viewing screen. The other beam is sent by a second mirror arrangement through the glass walls of the tunnel test section onto the screen where it is superimposed on the first beam. With no air flow in the test section, the mirrors directing the two beams are adjusted to give an interference pattern of dark and light bands, and a photograph of the pattern is taken. Flow is started and another picture is taken. The varying density throughout the flow causes a displacement of the interference bands. An interferometer picture is shown in Figure 1. The interferometer and schlieren pictures are of the same experiment and may be compared. Because the bands in most interferometer pictures are visible for some distance upstream where displacement is slight, identical bands in both the flow and non-flow pictures can be identified. Thus, the band displacements can be measured and density ratios computed for the field.

The interferometer is sensitive to dimension changes to the extent that a relative position change of three millionths of an inch between some of its parts will change the interference pattern. For this reason, the interferometer as well as every other piece of machinery in the building is vibration isolated. Mirror adjustment in the instrument is accomplished by means of self-synchronous motors driving a series of three micrometer screws.

To gain a better idea of the type of work carried on in the laboratory, let us look at some of the projects now under way there. One of the projects which promises to be of great value in the design of not only turbine compressor blades but of all supersonic apparatus is the investigation of the interaction of shock waves and

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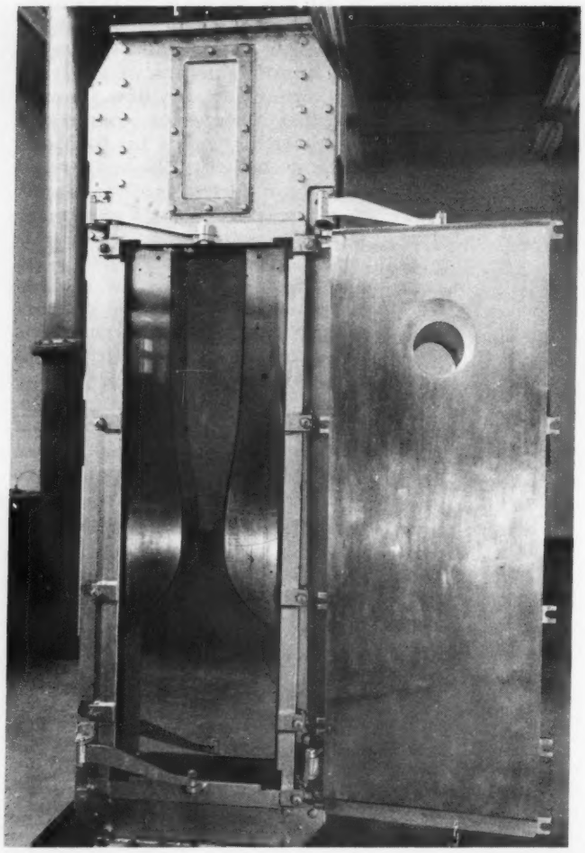
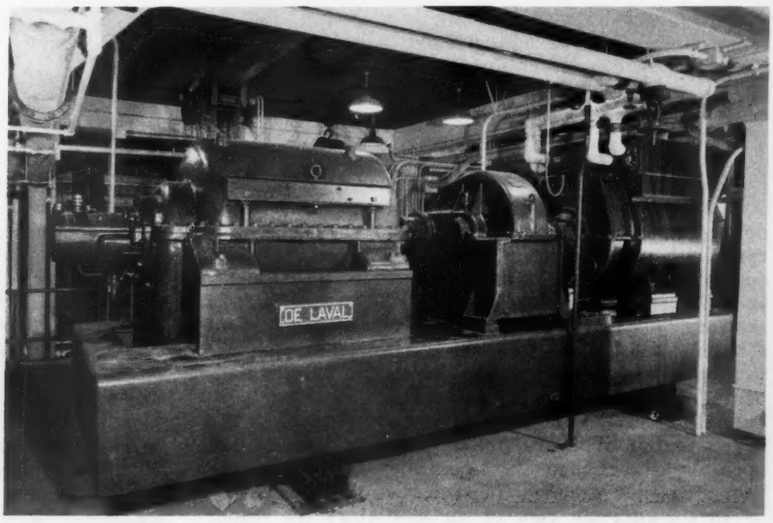


Supersonic wind tunnel test section appears above



Supersonic wind tunnel compressor and drive motor

engineering in palestine

A Young Tech Student's Account of Progress in His Country

Alexander Bloch, '50

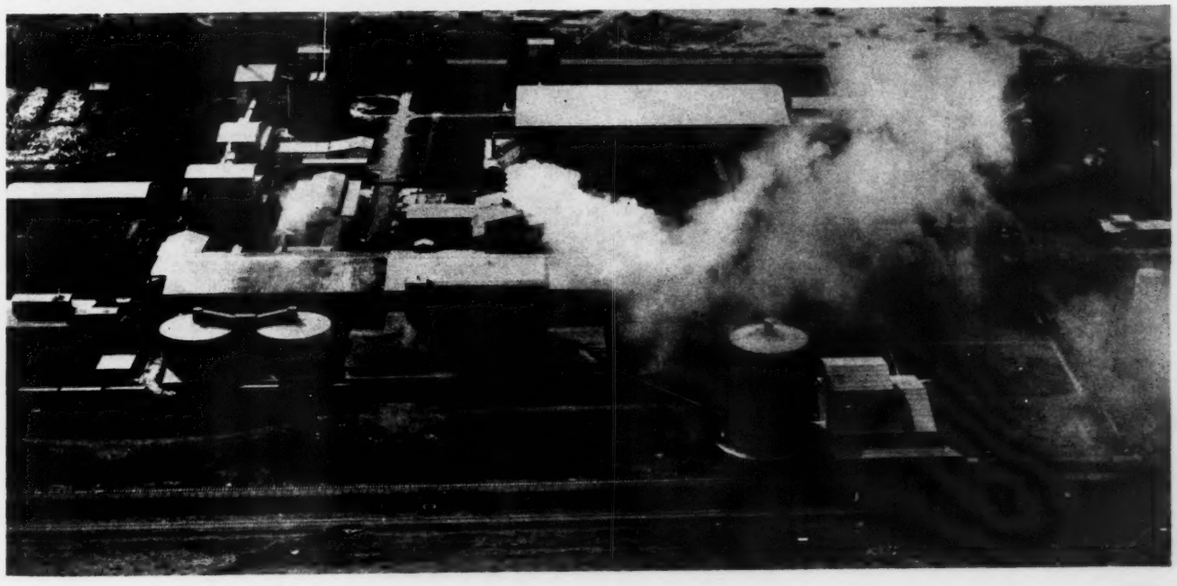
It is a very old country that I am writing about. Its history is long and eventful. Because of its strategic position as a link between Europe, Asia and Africa, for more than two thousand years wars have been waged and armies have marched to conquer this country. The kingdom of Judea was overpowered by its stronger neighbors and its inhabitants exiled. They returned. With the rise of Persia and the facilities granted to the Jews to return to their country reconstruction was quickly under way and once again prosperity returned to Palestine. Very soon, however, Macedonia, which became the major military power of its day, occupied the country. It stayed in control for some time until, in a war of liberation, they were defeated and thrown out. At that time Rome came into the picture and soon its legions were seen marching on Palestine's soil. Again revolts broke out, but, though fierce and heroic, they were unsuccessful against Rome's mighty power. In this struggle more than a million and a half people lost their lives from sword, famine or disease, and the country was laid bare. From that time on Palestine degenerated. Where once lived three million people in prosperity were now a handful who eked out a poor living. Soil erosion started to take place; swamps and deserts covered the face of the country. But still peace did not come. It was yet to pass through many hands till this day. After the Romans came the Byzantines, then the Arabs, the Crusaders, Napoleon, Turks. This is the historical setting of modern Palestine; this is the background.

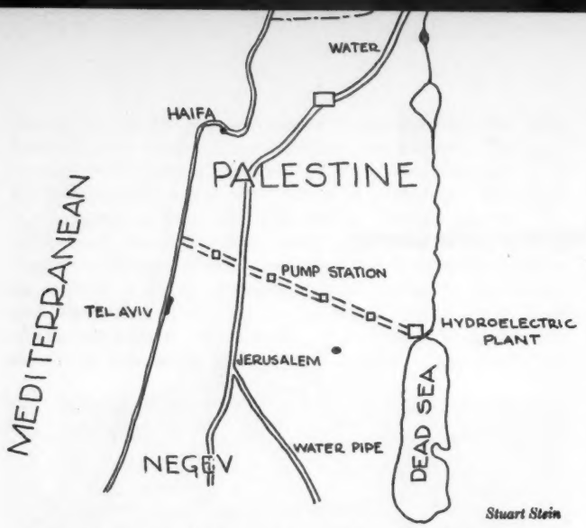
Only about fifty years ago, with the realization of modern Zionism and the return of the Jewish people to their country, did Palestine start to return to life. Swamps were dried by the pioneers, deserts irrigated, forests planted, and to all practical purposes a new country was founded.

The early years of the resettlement, at the beginning of this century, saw mainly agricultural activities, which of course are the basis of society, but as early as the twenties industry made its appearance and from then on continued to grow steadily. The coming of World War II gave tremendous impetus to this industrial expansion, for not only did the country produce its own consumer goods, but it also played a major role in the war effort of the Middle East.

Palestine is a tiny country, about the size of the

Below appears the Nesher Cement Factory at Haifa



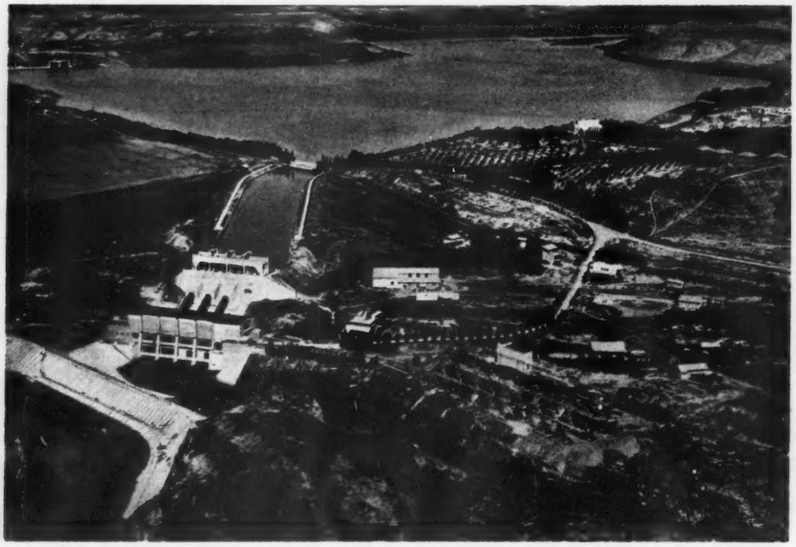


This map indicates the region where the Jordan Valley Authority would be put into effect

State of Vermont, but fortunately its topography and climate are varied, like Southern California's, so that it has all the variations of a large country — high mountains, deep valleys, etc. An important consequence of this, from an engineering point of view, is in the generation of electric power. At present power is supplied by the Palestine Electric Corporation and the Jerusalem Electric Corporation. The former has a concession for the whole territory except the Jerusalem area. There is one hydro-electric plant utilizing the waters of the Jordan and Yarmouk rivers. It has three vertical turbo generators with a capacity of 20,000 k.w.h. There are two steam plants, in Haifa and Tel-Aviv, each supplying approximately 30,000 k.w.h. The Jerusalem Electric Corporation develops its power from nine diesel engines developing a capacity of 15,000 k.w.h. In addition four of the larger industrial enterprises have their own electrical generators with a total of 15,000 k.w.h. It is obvious that for an expanding industry more and more power is needed and that the existing supply is totally inadequate. It is here in this connection that I want to mention the Jordan Valley Authority (J. V. A.), a plan based on the T. V. A. and proposed by the United States Assistant Director of Soil Conservation, Dr. Walter C. Lowdermilk. This plan is in short as follows: The Jordan River, which normally flows from the foot of Mount Hermon into the Dead Sea, is to be diverted and by means of canals used to irrigate the dry parts of the country. But still more important than this will be the conduction of water from the Mediterranean through tunnels to the Dead Sea, 1300 feet below sea level, to offset the water lost from the Jordan. Since there is a drop of about 1300 feet over a very short distance, hydro electric power could be obtained up to 800,000 k.w.h., and this would make a big industrial expansion possible. Of course the project requires many engineers and skilled technicians, but the costs are within reason. When normal conditions again prevail, the plan may be started.

Palestine's present day industries cover a very wide field, although of course when compared with the United States they will seem very small indeed. Nevertheless, when one considers the start made just a few years ago, the advance is enormous and today Palestine is the most industrial country in the Middle East.

In the field of mechanical engineering a very fine machine tool industry has been developed, producing all the machinery needed for modern production.



Haifa harbor, one of the busiest ports of Near Eastern trade and the terminal of the Iraq pipeline.

The first Jordan power house, in operation since 1932; its capacity is 25,500 h. p.

Anglo-Palestine Bank in Tel Aviv

Light and medium lathes, drills, punching presses and shapers are manufactured as well as some heavy items such as hydraulic presses, cranes, etc. The Vulcan foundry in Haifa is the largest and most modern of its kind in the Near East and is equipped for heavy castings. There is a very efficient, though quite small, plant in Tel-Aviv manufacturing boilers, and a few years ago a factory was founded for the production of car bodies. Incidentally, today this plant turns out armoured cars, needed for the unsafe roads, at a very great rate. Precision instruments and tools are also turned out, and high hopes are connected with this industry. Special mention should also be made of the machinery and tools for the diamond polishing and cutting industry, which is equipped exclusively by Palestinian manufacturers. The rise of this diamond industry was a most spectacular one indeed. From 200 in 1940 its personnel increased to 3500 in 1944 and the value of its export rose in the same period from $100,000 to $14,000,000. About 70 per cent of the total production in 1944 was exported to the United States. On the whole, however, the mechanical engineering industry, especially the production of consumer goods, is based on small workshops and the really big enterprises with the assembly line have yet to be introduced. American engineers could do a very good job in this respect. With regard to future development in mechanical engineering there are great possibilities in the manufacturing of motors, diesel engines and farming implements, which at present are produced only on a small and limited scale.

The electrical engineering industry, though still in its infancy, is off to a good start. Transformers, measuring instruments, electrical wire, and almost all consumer goods in this category are manufactured in Palestine. Still, a lot can be done in this field, especially in the line of electrical communications.

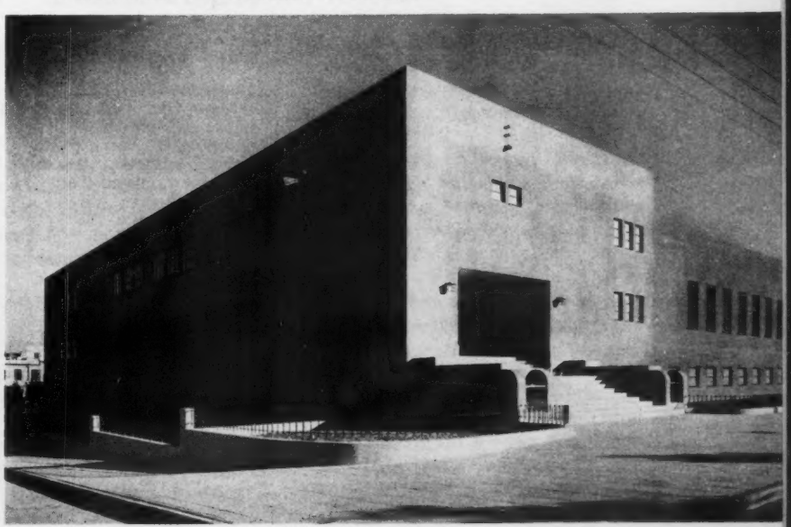
One of the biggest industries in Palestine is the textile industry. It is almost completely mechanized, and a great many of its power looms are manufactured in Palestine. The growth of this industry was also very spectacular. In 1937 the number of establishments was 86 and rose to 247 in 1942. The production value added in that period was $8,000,000. Recently dyeing and finishing mills, a mill for print cloth, and a wool washing plant have been added, and hence makes this industry an all-round one. The quality of its products is of a very high standard and compares favorably with foreign manufacture.

Two other industries I would like to mention are the food and the chemical industries. Both are already producing on a relatively big scale and show great future promise.

Palestine, being one of the world's biggest growers of citrus fruit, has a natural advantage in the production of fruit juices. This advantage has been exploited in quite an efficient way; by 1944 the export of juices and essential oils topped the $1,000,000 mark. Soap and oil are also exported, the biggest enterprise being the very modern "Shemen" Co., whose products are known the world over. With respect to the chemical industry we have here too made an enormous advance, especially in the pharmaceutical line. The value of the export of drugs and medicines reached $800,000 in 1944; hence since this industry too is the only one of its kind in the Middle East its prospects are very promising. Glue, enamel, varnishes and paints are also exported. Part of the chemical industry, although it may, because of its size, be classified as an industry by itself, is the Palestine Potash Co., which extracts potash, bromine and other minerals from the Dead Sea. The development of the potash industry can be

(*Continued on page 352*)

A schoolhouse in modern Palestine



the tech engineering news

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the dragon's den

A Promise to Fulfill

With this last issue of Volume XXIX, we might consider briefly what has been done this year and look to next year to see what to expect. *T. E. N.* has slowly but surely during the past eight months been livened up. Our covers were perhaps first to foretell the new trend, but the articles of general interest to the student were soon to follow. The last notable change has been the new layout, which we hope has met with our readers' approval. As mentioned, we have been increasing the number of articles of general reader interest. The magazine is still the TECH ENGINEERING NEWS and furthermore it is the professional journal of the undergraduates at M. .I. T. The slightly new note is that we feel we should cater to the students as a group of people with certain common interests. A professional group you might call it, the profession being one of getting an education.

For all students going to M. I. T., the school itself should be one of their vital interests. Their future success depends to a great extent on what the school does for them and to them and on how M. I. T. is regarded in the world around it. For this reason articles such as the one in this issue on the Division of Industrial Co-operation are of significance to the student. We can not guarantee that all that we publish about Tech will be in the nature of praise or will pat ourselves on the back. But our promise for the coming Volume is that we shall cover the Institute as best we can, all the time keeping in mind the interests of the students.

The Zoo

With final exams almost here, most of us will soon be leaving M. I. T. for the summer at least. This prospective renewal of our contact with the world away from Technology gives us pause to wonder in just what light we are seen by others who are not connected with M. I. T. In most respects our school has a reputation which is a worthy subject for pride but also worthy of a second thought.

In the first place is Tech really as formidable as many people think it to be? This question is significant, for upon the men that come here to school rests the future reputation of M. I. T., and as a result the rating we shall have in the eyes of other men. If, as sometimes appears to be the case, the idea becomes popular with high school students interested in science and engineering that it is next to impossible to get accepted into M. I. T., many perfectly eligible men will not even try to enter. We know perfectly well that it is not impossible to enter Tech or to stay provided you are at all suited for a technical education. When people on the outside think differently, the students and the school suffer, for we lose good men to other schools.

It is quite fitting that we should take pride in the rigorous training we receive here at M. I. T., but neither we students nor the faculty should consciously or unconsciously spread the notion that we are doing the impossible. That is if we want more and more well qualified men to want to go to M. I. T. If others think Techmen capable of doing what nobody else can, we may swell with pride, but the chances are that the others will also think us queer as well. As something fit for the Zoo.

That thought brings the recent Open House to mind. Thousands of people may have wandered through the halls of the Institute, but what was the spirit in which they came and what did they have on their minds? To the casual observer who mingled with them for several hours, they seemed like the crowd one would find on a gala day at a combination zoo, museum, and world's fair. None of those words fittingly describe any phase of M. I. T.

The crowd respected Tech's research but hardly understood. However, there scarcely seem to be any general realization that M. I. T. is a center of education where students live and work in a kind of community. It is difficult to criticize Open House, for if it had been anything other than a collection of scientific peep shows and a display of numerous gadgets, the crowd that came would have been disappointed. But we all can accept the responsibility for allowing that attitude to develop in the people who came to Open House. It is up to us to let people know what we do here. Let them know that Tech is a school, but it is not a factory. That there are many things far removed from studies or research which go on around here and that while we hope we are better trained than the next man, we are actually no different from him.

E. T. M.

HANDLING HEAT with Abrasives

Handling the high temperatures used by modern industry is a tough job—it requires materials with rugged physical and thermal properties. Norton has such materials in Alundum and Crystolon abrasives. Their creation in electric furnaces at temperatures of 3700° and 4000° Fahrenheit gives them valuable refractory properties as well as abrasive qualities. And supplementing these two materials there are several Norton electric furnace products which are produced especially for their unique refractory properties.

These various refractory materials are put to effective use in Norton cements, tubes, bricks, plates, tiles and other shapes for

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There's also a line of Alundum refractory laboratory ware such as crucibles, cones, dishes, discs, thimbles and combustion boats for ignition, incineration and filtration.

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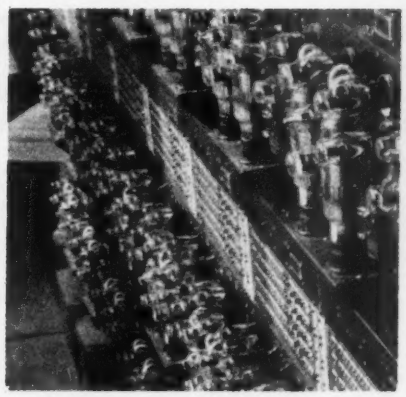
industry and education

(*Continued from page 325*)

the helium will creep up and over the walls separating the two bodies of liquids until equal levels are realized. Not only does the helium display strange viscous characteristics, but it also has tremendous heat conducting properties. It does not absorb the heat but rather transmits the heat with little or no losses.

It would take a lot of imagination to dream up any useful applications for supercooled lead or helium, but this research is not aimed at development but only at learning more about substances and physical laws. However, before anyone shrugs off low temperature work, let it be remembered that no one could imagine any useful application for a metallurgical professor's process for growing crystals. It took a war to find a use for these man-made crystals in radio equipment.

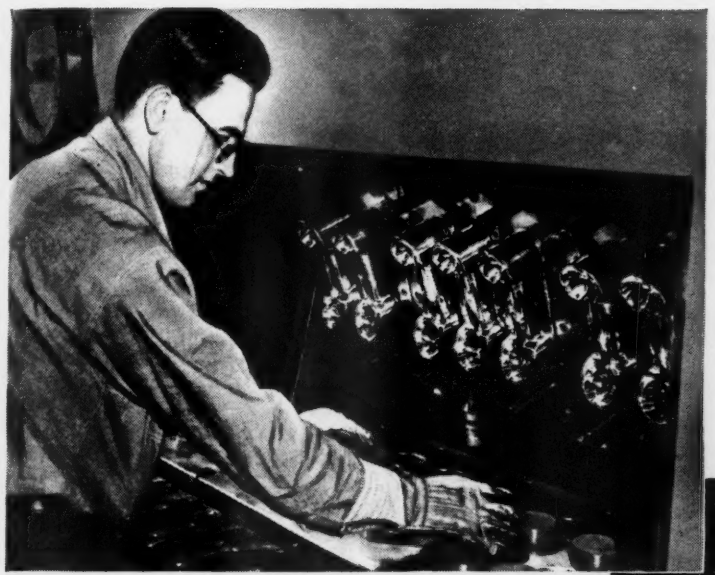


A view of some of the many tubes in the D. I. C.-built differential analyzer

There are few educational departments which have not engaged in D. I. C. programs, and at present all except four departments are working on some project. The war brought many projects to the Institute which virtually doubled the size of the department in a matter of months. Though the close of hostilities did bring a large cut in contracts, the present volume of contracts is far above pre-war figures and show excellent signs of increasing. The D. I. C. is definitely a necessary department — necessary to the Institute, to the student, and to industry — and though some may dislike the idea of having industrial projects in an educational institution, the principle of operation allows all concerned to improve themselves through aiding someone else.

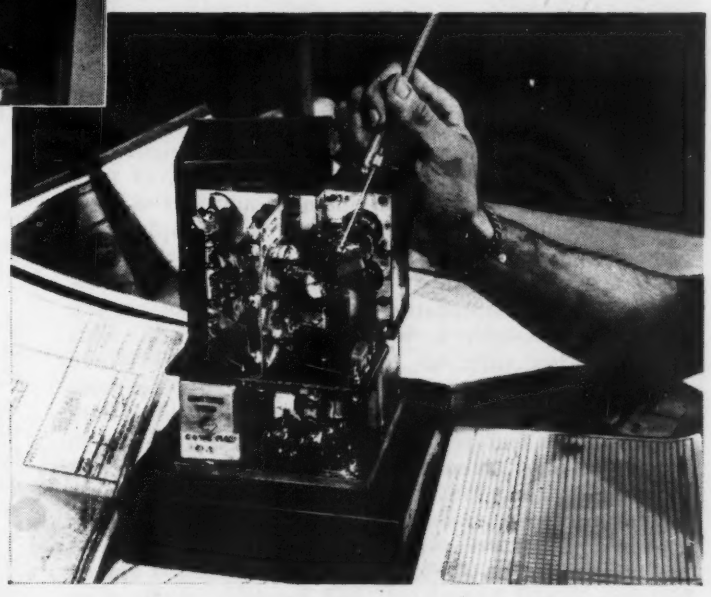
NUMBER 11 OF A SERIES

Newsworthy Notes for Engineers



How to make handset handles twice as fast!

To meet the tremendous postwar demand for telephones, Western Electric engineers were faced with the problem of molding 50% more plastic handset handles per day than ever before. Calling on their wartime experience, the engineers turned to electronic pre-heating, which raises the temperature of the phenol plastic from room temperature to 275 degrees Fahrenheit in just 30 seconds. In this way they cut press time in half, doubled production, improved the finish and increased the strength of the handset handles through more uniform heating.



Laboratory precision in mass production

This line amplifier looks like something made in a laboratory—and destined to spend its life there. Actually, the amplifiers are mass-produced to lead rugged lives up poles, down manholes, or in remote repeater stations along coaxial telephone cable routes. Each amplifier must boost the volume of as many as 600 voice channels, ranging from 64 kc to 3,096 kc, with closely controlled characteristics over long periods without attention. Working out manufacturing methods and controls that assure uniform performance of laboratory precision in telephone equipment is always an interesting project to Western Electric engineers.

Engineering problems *are many and varied at Western Electric, where manufacturing telephone and radio apparatus for the Bell System is the primary job. Engineers of many kinds—electrical, mechanical, industrial, chemical, metallurgical—are constantly working to devise and improve machines and processes for mass production of highest quality communications equipment.*

Western Electric

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8. Improve your product with a quality fastener.

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY
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dead land of the deep

(*Continued from page 327*)

ever known, he was well over six feet in height and possessed a brain capacity larger than that of man today. He had a sense of refinement and was skillful, as is shown by his drawings and his clever implements of bone and horn. Yet there are no traces of the intermediate forms that must have existed in his development from more primitive man, at least not on the land now accessible to archaeological research. This fact, together with his presence in a corner where Atlanteans would most likely enter Europe, is one more point in favor of the existence of an Atlantis. There are two more features in connection with Cro-Magnon man that strengthen this argument: in none of his drawings is there anything resembling a ship, a fact which practically rules out his coming far by sea (for certainly, if he were very familiar with this mode of transportation, he would have left a record of it among his more trivial depictions); and, secondly, skulls of an ancient race have been found in Lagoa Santa in Brazil that strongly resemble those of the Cro-Magnon.

A similar living mystery is presented to science in the case of the Basques, a small race of people inhabiting the rugged mountains of the Franco-Spanish border. Both in appearance and in language are they almost totally different from the Latins all around them. Instead, their grammatical structure is held by some authorities to closely resemble that of the language of certain American aborigines. Certainly of significance is the tradition held among them that they originally came from a land to the West which has since disappeared.

Nor yet are these the only instance of "lost" races. The Canary Islanders bear little resemblance to any African groups, but rather show signs of some relationship to the Indian tribes of Central America. In particular, these island inhabitants at one time mummified their dead with a certain plant; and remains of both this plant and the particular method of mummification are only found elsewhere in certain regions of Central America and Peru.

You are undoubtedly familiar with the story of the great flood as presented in the Old Testament writings of the Hebrews, but do you also know that practically identical stories are to be found in the records and legends of countless races and tribes, present and historic, the world over? However, by no means all of the lands whence come these folk-lores have been inundated. Where did these scattered peoples learn the story? Might it be a memory of a catastrophe which was witnessed by a common ancestral race and then later transmitted to succeeding generations through the ages?

For evidence that is really extensive in amount, we can turn next to the botanist and the zoologist. In instance after instance they point out to us the existence of species of plants and animals on both sides of the Atlantic that are identical in form, species that could never have crossed the present-day Atlantic Ocean. They name ants, moths, butterflies, and earthworms, to mention but a few as examples.

There has been ample reason given for the belief that there was an Atlantis; there is related evidence that, at some time before recorded history, a single race of humans had established its influence in a tenuous

(*Continued on page 344*)

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Dan Sully

A diesel-powered back-hoe at work excavating for the Institute's new library

the
new
tech engineering news

is written for
the student

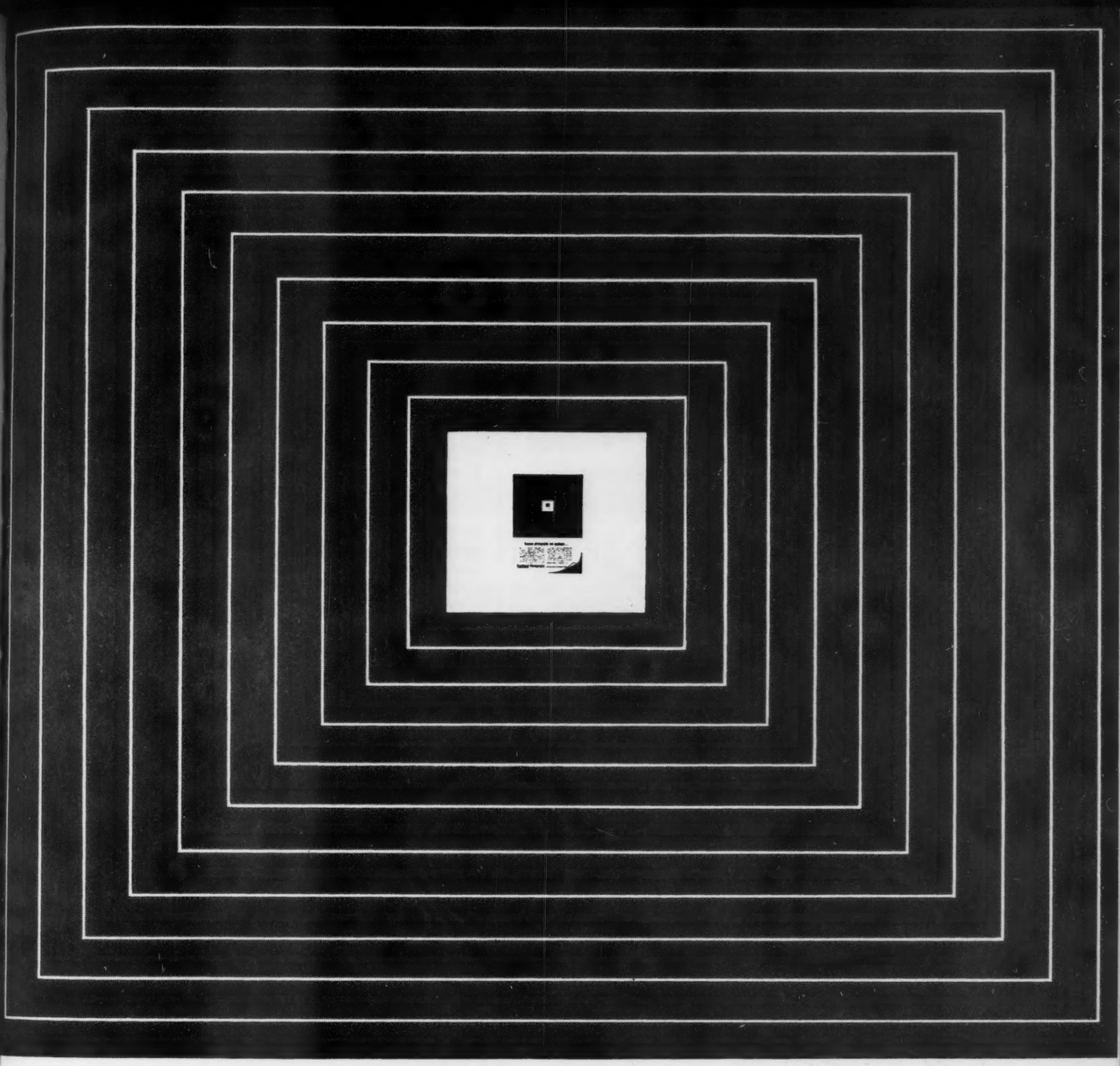
not
the professors

not
the brownbagger

but—
THE STUDENT

t. e. n.

june, 1948 . . . november through june, 1949



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You can utilize it to make sales presentations more complete, more resultful. With motion pictures, you can "pack" a plow, a plant, a whole process into a small can of film . . . travel it where you will . . . show it off "large as life" and much more dramatically.

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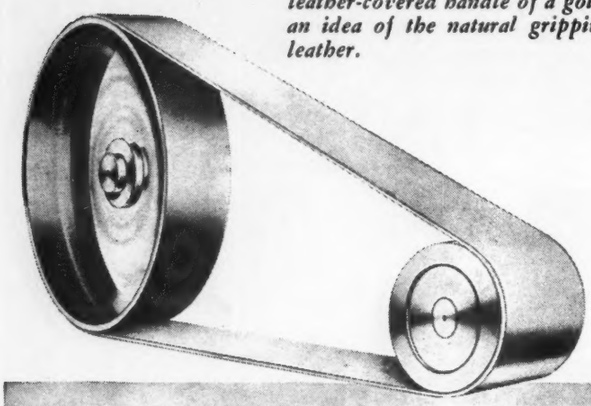
LEATHER HAS THE GIFT OF "GRAB"

that puts power to work

When you wrap your hands around the leather-covered handle of a golf club, you get an idea of the natural gripping capacity of leather.



That same grip or high coefficient of friction makes leather an outstanding material for modern power transmission. The full-grain, pore-like surface of a leather belt provides a positive, non-slip pulley grip that assures continued maximum efficiency.

That's why leather belting is turning so many wheels in today's industry.

AL-17

American LEATHER BELTING *Association*

Headquarters for Authentic Power Transmission Data

41 PARK ROW, NEW YORK 7, NEW YORK

dead land of the deep

(*Continued from page 340*)

band around the globe. It is thought that they lodged in the Mediterranean, in India, in China (only on the Pacific coast), throughout the Pacific, and in Mexico and Peru. From the fact that they never extended very far inland, it could be deduced that they were seagoing people. Other characteristics which constantly serve to identify them in widespread areas are: circumcision, worship of the sun, mummification of the dead, deformation of the head, tattooing of the skin, erection of monuments such as those at Stonehedge in England, a practice of sending the father to bed when a child was born, a religious association of the sun and a serpent, and the use of the swastika.

Did there at one time originate on a lost continent of Atlantis a civilization so advanced as to extend its influence in a line around the world, long in the unknown centuries of the past? Evidence that a single race inhabited the earth at one time is very nearly as good as that that Atlantis formerly existed. One of the problems now is to connect these scraps of information.

The question of the existence of Atlantis presents an ideal opportunity for the exercise of scientific reasoning. The circumstantial evidence is of such combined weight as to overwhelm one into accepting the theory. But such precipitousness is just what is to be avoided in the proof of anything. Of course, there is a limit to the amount of reserve to be shown, but that limit has not yet been reached in this instance. In the meantime, as we accumulate our facts, there is no harm in indulging in daydreams, for these very dreams often become the starting point of theory. It is certainly possible for Atlantis to have existed and it is even probable that it did. It was in the face of such widespread incredulity as is now bestowed upon the Atlantis supposition that Schliemann, the German archaeologist, proved to the world the existence of classical Troy through the success of his excavations at Hissarlik in Asia Minor. It is interesting to note that this same man held just as firm a belief in the idea of a sunken Atlantis.

Whether or not Atlantis existed, and, if it did, whether it had a really advanced civilization or not will very likely never be answered completely. When we find, though, that there is in reality a huge elevated region where Plato located Atlantis, that huge continents have occupied the Atlantic at one time, that these land masses have finished their breaking up and subsidence only recently, that certain areas of the deep must have been "afloat" within man's stay on earth and, consequently, within his period of observation, and that furthermore to all this evidence the sciences of biology, archaeology, ethnology, and philology have added their own testimonies — often totally unrelated — does it not seem as though we are facing in the legend of Atlantis fact rather than fable?

Continuous homogenizing* furnace in which phosphor bronze is prepared for cold rolling.

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Roller hearth radiant tube heated furnace using prepared atmosphere for bright annealing.

Atmosphere generating equipment used with bright annealing furnace.

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So company production engineers, already familiar with GAS and Gas Equipment, specified the modern method of heat treating—with continuous, automatically-controlled, Gas Furnaces, with integral prepared atmospheres.

Here are the processes . . .

Process—*Homogenizing—a method of heat treating to develop uniform grain structure in phosphor bronze billets prior to rolling, while relieving casting strains.
Temperature—1200° F.
Cycle—6 hours
Furnace Capacity—2000 lbs. per hour

Process—Annealing of bars and sheets in a prepared-atmosphere furnace to retain brightness while relieving stresses set up during rolling or drawing operations.
Temperature—1200° F.
Cycle—40 minutes to 3 hours, varying with stock size
Furnace Capacity—5000 lbs. per hour

Here are the results . . . .

1. Pickling process eliminated
2. Production increased 80%
3. Uniformity of heat treatment assured by automatic control
4. Annealing and homogenizing costs reduced over 50%
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Signature of Dean.....

f. m. — new developments

(*Continued from page 329*)

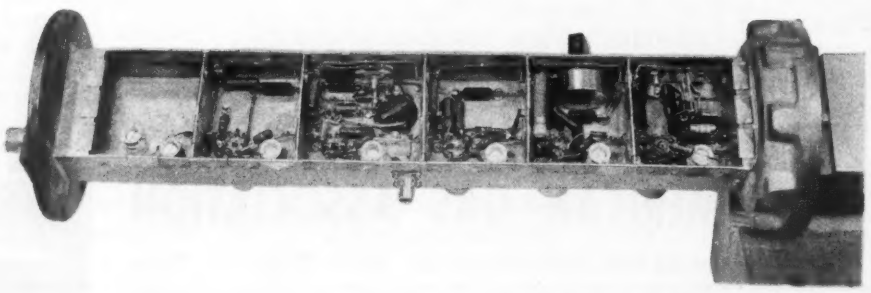
output depends upon the frequency of the resultant signal. The output frequency is a function of the rate at which the resultant signal assumes zero values. This rate is shown in Figure 6, where the frequency remains near $p + \frac{r}{2}$, but takes periodic excursions over a frequency range of about two megacycles. In order to avoid distortion, the limiter and all subsequent radio-frequency circuits must be designed for a pass band of ± 2 megacycles.

Figure 7. Fundamental block diagram of the simplest conventional F. M. receiver

Another way to look at the situation is to consider what happens when the two waves are impressed upon a conventional receiver. What is basically desired is to have the receiver respond only to the stronger signal, which has a frequency of p, in Figure 6. The resultant frequency of the two signals has a value of $p + \frac{r}{2}$ over most of the cycle, but takes a sharp drop of almost two magacycles for a short period of time. This drop has the effect of bringing the average frequency taken over a time interval of several cycles to a value of p, which is precisely what is desired. However, the average value of the resultant will not equal p unless the entire frequency excursion of the resultant signal is passed by the receiver. Referring to Figure 6, the frequency dip or "spike" may extend as far as two megacycles below p or two megacycles above p, depending upon whether signal a is less than, or greater than 1. A pass band of four megacycles is therefore required. This range is

(*Continued on page 354*)

An underside view of part of the receiver. The bottom-plate has been removed to reveal the internal construction. The test model was built on three sections of wave-guide. This type of construction provided easy accessibility, and simplified shielding problems



THE HRO-7C
finest model of
the world's
most famous receiver

OVERALL DIMENSIONS:
Height 29", width 20¾" depth 14¾",
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- The incomparable HRO-7
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National
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basic research in gas flow

(*Continued from page 332*)

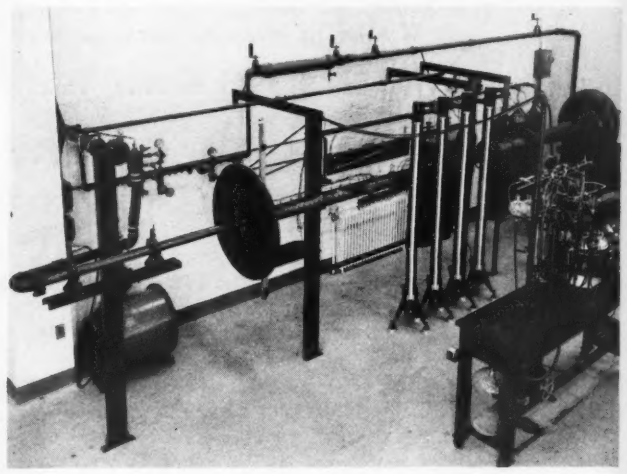
boundary layers. To obtain such information, a wedge, adjustable in position and angle of attack, is placed in a supersonic air stream of rectangular cross section. The wedge initiates shock waves which are photographed by both the schlieren apparatus and the interferometer. By the use of these photographs, examples of which have already been shown, it is possible to study the build up of the boundary layer and the effect of normal and oblique shock waves on the action of the boundary layer. The study, which promises to be very long range in nature, has already shown a marked interrelation of boundary layer and shock wave action.

Because gas leaving the exit nozzle of a gas turbine is not homogeneous, one of the most pressing problems encountered in testing gas turbines is that of securing representative samples of exit gas for analysis to determine the efficiency of the combustion process. Now under way in the Gas Turbine Laboratory is an investigation to determine means of securing a true analysis of exit gases. This study has developed an air motor mechanism for producing a high speed stream made up of slugs of air and CO_2 in known amounts. A shadowgraph method is being investigated for use in analyzing the stream.

Other experiments being conducted in the combustion area of the laboratory are designed to investigate the problems of flame propagation and stabilization in high speed air streams. A third problem along the line of combustion work is an investigation of the mechanism of mixing between two concentric gas streams which flow parallel to each other. The inner stream is composed of 90 per cent air, 10 per cent helium, while the outer stream is 100 per cent air. Measurements of velocity, concentration, and temperature at various cross sections of the flow path downstream of the introduction point of the inner stream will be used to study the mixing process. The effects of velocity ratio, area ratio, and turbulence on the mixing will be investigated, and the results will find application in the design of combustion chambers and jet pumps.

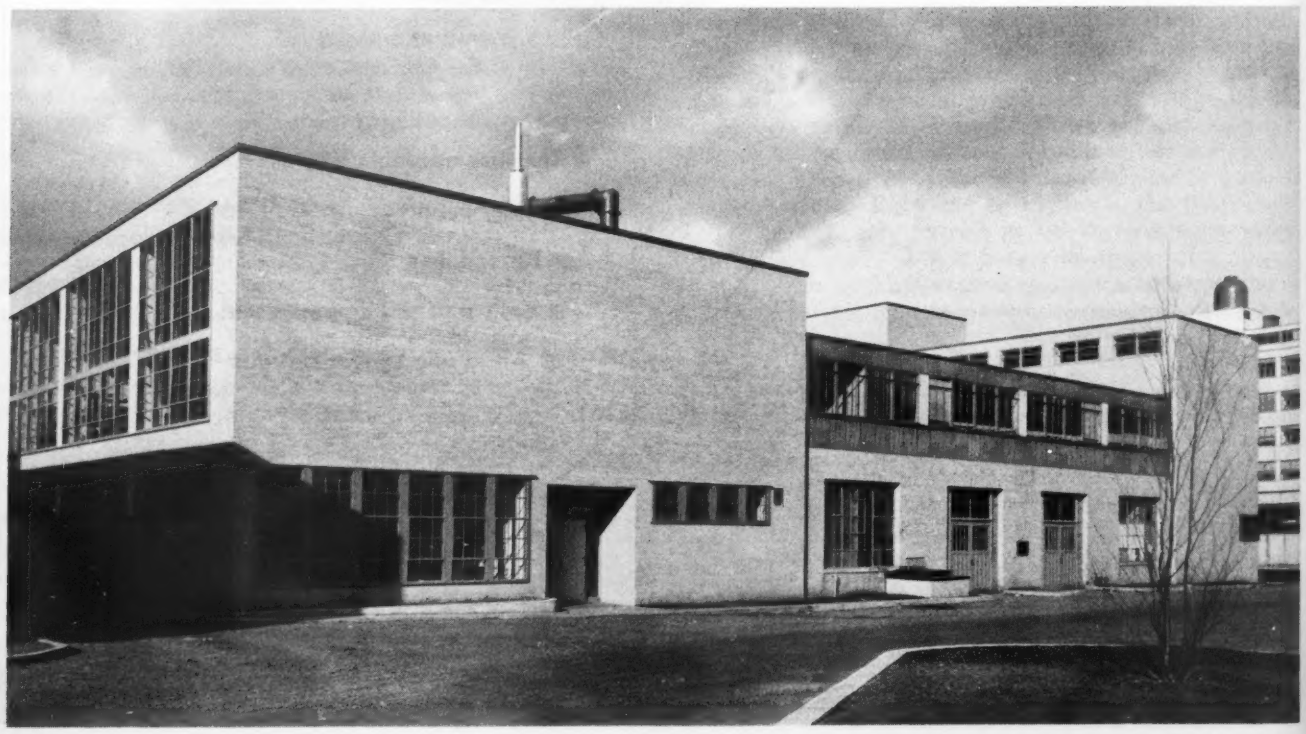
One of the larger projects of the laboratory is the study of supersonic diffusors such as the one on the supersonic wind tunnel downstream of the test section. By testing diffusors of various shapes, both of fixed and variable geometry, the laboratory is endeavoring to design a diffusor of the highest possible efficiency.

The projects stated above well illustrate the fact that the Gas Turbine Laboratory at M. I. T. is staying within its chosen sphere of activity — long range, basic research of problems connected with gas turbine design. The effort of the laboratory to discover the principles of supersonic fluid flow will certainly have as its effect the advancement of the development of gas turbines and supersonic aircraft, for movement at speeds higher than ever before accomplished.



Apparatus for investigating the mixing of two concentric gas streams

An exterior view of the new Gas Turbine Laboratory

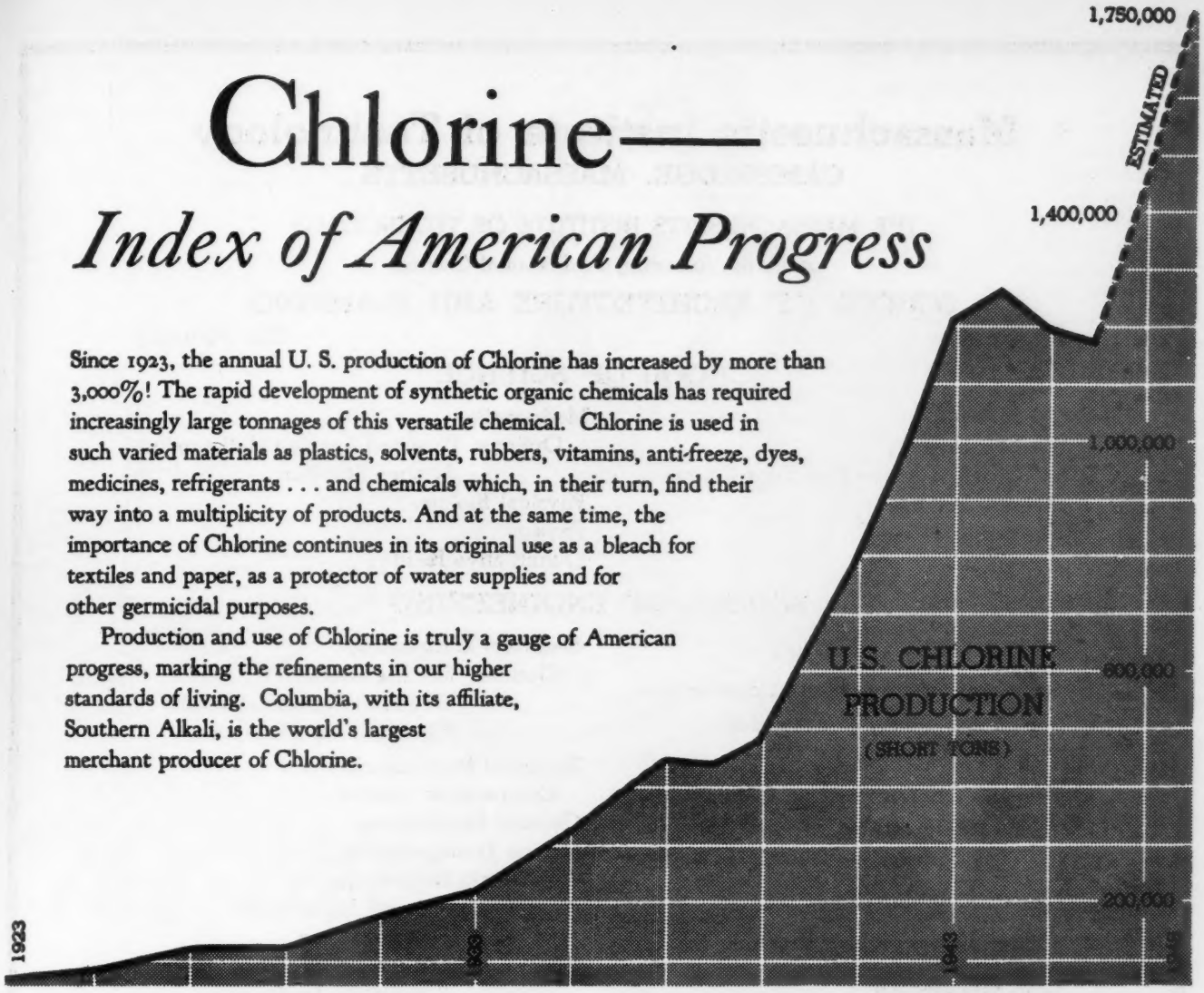


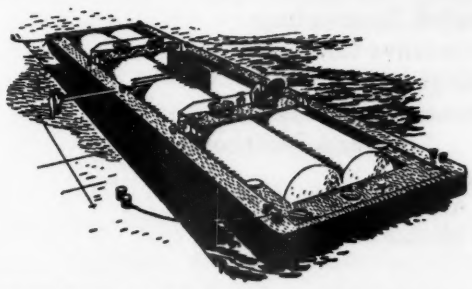
Chlorine——

Index of American Progress

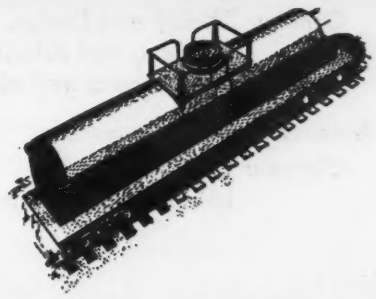
Since 1923, the annual U. S. production of Chlorine has increased by more than 3,000%! The rapid development of synthetic organic chemicals has required increasingly large tonnages of this versatile chemical. Chlorine is used in such varied materials as plastics, solvents, rubbers, vitamins, anti-freeze, dyes, medicines, refrigerants . . . and chemicals which, in their turn, find their way into a multiplicity of products. And at the same time, the importance of Chlorine continues in its original use as a bleach for textiles and paper, as a protector of water supplies and for other germicidal purposes.

Production and use of Chlorine is truly a gauge of American progress, marking the refinements in our higher standards of living. Columbia, with its affiliate, Southern Alkali, is the world's largest merchant producer of Chlorine.





NEW COLUMBIA BARGES offer numerous advantages to large-volume chlorine consumers located along the Ohio-Mississippi waterways. Each barge has a capacity of 600 tons and has many features for safety and simplicity in loading and delivery.



55-TON CHLORINE TANK CARS were first placed in service through Columbia assistance in design. Complete transportation service includes 30-ton single unit tank cars . . . multiple 15 one-ton unit cars and 100 and 150 lb. all-steel cylinders.

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The duration of each of the above undergraduate Courses is four academic years and leads to the Bachelor's degree, with the following excepiions: Architecture, Marine Transportation, Food Technology (Five Year Course), Physical Biology, and the Co-operative Courses in Electrical Engineering and in Mechanical Engineering, which extend over a period of five years. In addition to the Bachelor's degree, the above five year courses lead also to the Master's degree, with the exception of Architecture and Marine Transportation which lead to the Bachelor's degree only.

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A five year Course is offered which combines study in Engineering or Science, and Economics. This leads to the degree of Bachelor of Science in the professional field, and to the degree of Master of Science in Economics and Engineering or Economics and Natural Science.

For information about admission, communicate with the Director of Admissions.

The Catalogue for the academic year will be sent free on request.

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Big? Yes . . . but not so big as to swallow up its promising young men. Old? Yes . . . but not too old to adopt young ideas that are sound. Pennsalt was founded by a young man; and grew large through the efforts of young men.

The future, too, looks bright for Pennsalt . . . and for the young men who are going to build it. Pennsylvania Salt Manufacturing Company, Philadelphia 7, Pa.

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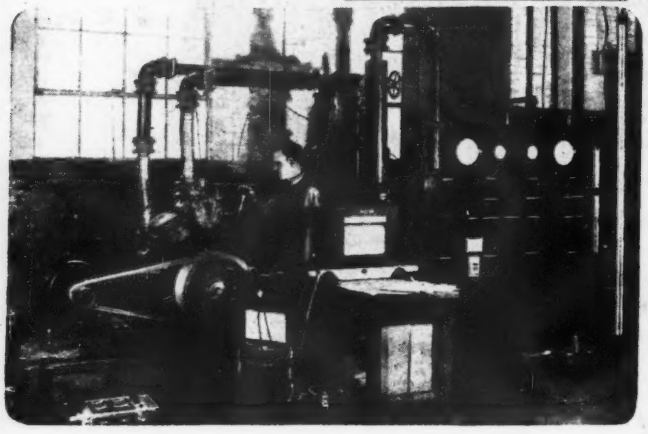

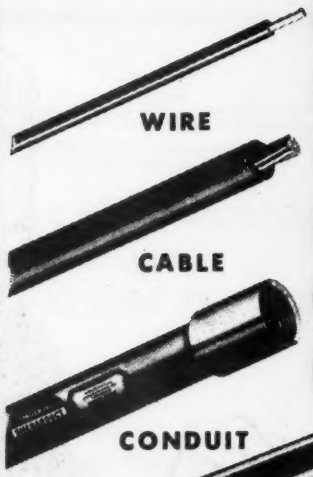

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National Electric Products Corporation

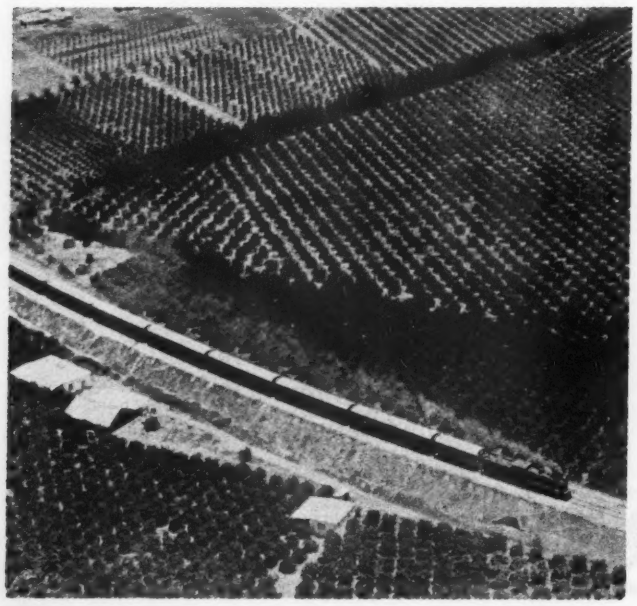
Pittsburgh 30, Pa.

engineering in palestine

(*Continued from page 335*)

shown from the amount of crude potash exported, which amounted to 18,124 metric tons in 1935 and 103,121 tons in 1943. As a by-product bromine and bromine salts have been extracted and these by-products proved especially valuable during the war since they are used in the production of high octane gasoline for aeroplane use. In the future it is hoped that the Dead Sea brines will give rise to still another industry, namely the manufacture of magnesium metal. The Dead Sea water contains an unusually high concentration of magnesium salts — eight to nine times that in the ocean — while the total magnesium content of the Dead Sea is estimated at 5,900 million metric tons. Now that magnesium plays an ever increasing part in industry, the prospects of this industry being established become very great and promising indeed.

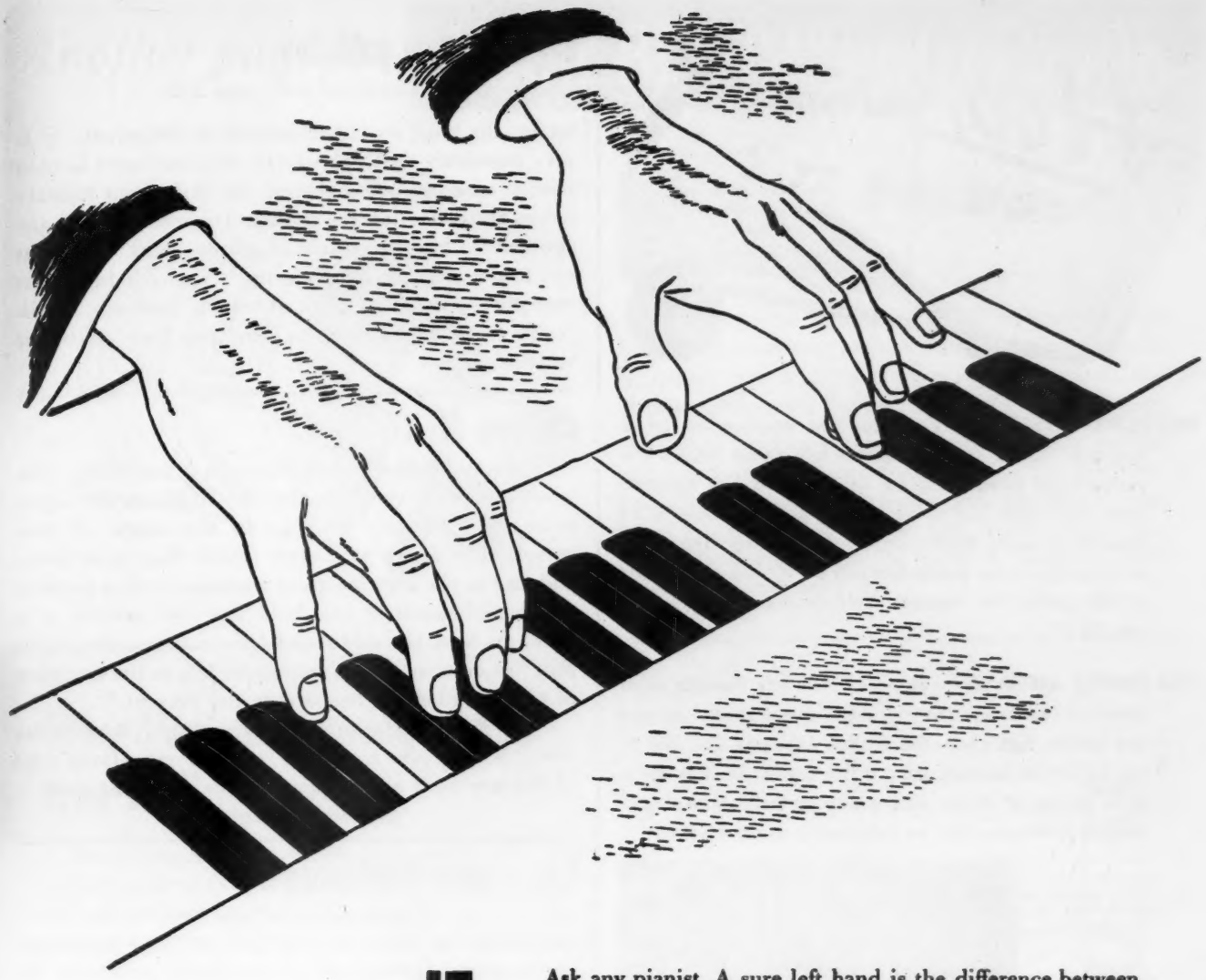
A train moving through the citrus region around Sharon



Now I would like to mention two individual industrial enterprises. There is the "Nesher" portland cement manufacturing plant, which, like so many others I have mentioned before, is the only one of its kind in the Middle East. This plant is a very modern and efficient one and has at present an annual capacity of 250,000 tons. Since it is expected that an all-out construction program will take place as soon as conditions permit, this plant is likely to expand. Of interest also is the petroleum refinery in Haifa, the Consolidated Refinery Co., which was founded in 1938 but was not completed until the outbreak of hostilities at the end of 1939, and which was immediately thereafter geared for wartime production. Haifa, which is the terminal of the Iraq pipeline, was the natural point of the establishment of this plant. By 1944 consumption of crude oil in the refinery reached 3.9 million tons and among its products were benzene, kerosene, gas oil, furnace oil and asphalt.

I have thus covered in short the engineering aspects of modern Palestine. The industry is very young but it has made a very promising start. With skilled engineers and technicians to help, the country may go very

(*Continued on page 354*)



IT TAKES BOTH HANDS

Ask any pianist. A sure left hand is the difference between a master and a might-have-been. That's going to be true in your own field, too, after you've hung up your mortarboard in somebody's industry. To get to the top, you'll build on the fundamentals you're learning now, keeping up-to-the-minute with the latest trends and developments in your field.

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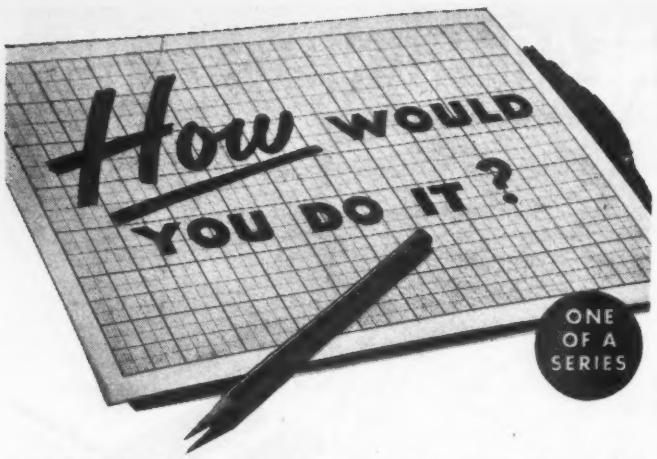
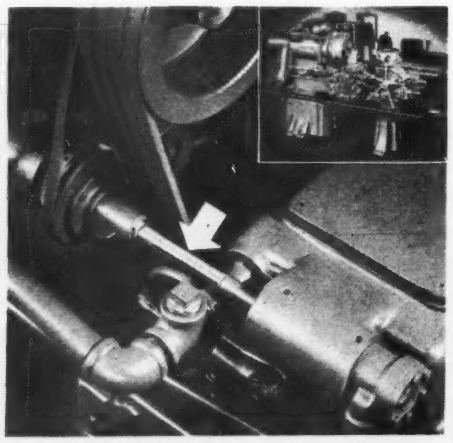


PROBLEM — You're working out the application of a hydraulic speed selector system to a turret lathe. The system's oil pump is to be driven by a belt take-off from the main belt drive. Your problem now is to provide a means for transmitting power from the pump drive pulley to the pump that will permit the adjustment of the pulley to regulate belt tension. How would you do it?

THE SIMPLE ANSWER — Use an S.S.White flexible shaft between the pulley shaft and the pump shaft. As you see below, that's how the Gisholt Machine Co., did it. An S.S.White flexible shaft is the logical answer for a wide range of drives where one or both of the connected members must be adjustable in position.

Photos courtesy of Gisholt Mach. Co. Madison, Wis.



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engineering in palestine

(*Continued from page 352*)

far on the road to full industrial development. It is very promising that Palestinian manufacturers have in a large measure accomplished the shift from military orders to production for civilian demands without any appreciable loss in volume of employment. This was and important test and Palestine's young industry has emerged successfully from it. It is now up to the young engineers to continue what has been started so successfully.

can you do it?

A party of three married couples is travelling. The wives are young and beautiful, the husbands are impetuous and extremely jealous. In the course of their travels they arrive at a river which they must cross, and find as the only means of transportation a rowboat which unfortunately can hold but two persons at a time. In order to avoid scandal and intrigue, they agree that "at no time shall a woman be left in the company of a man, unless her husband is also present."

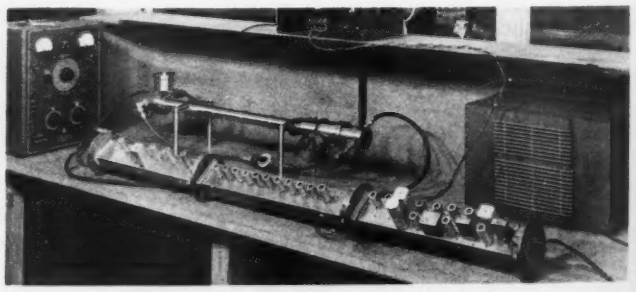
How shall they arrange their crossing? (Women can row.) We can give a solution in which only eleven trips of the row boat are required. Can you do as well?

Solution on page 356

f.m. - new developments

(*Continued from page 346*)

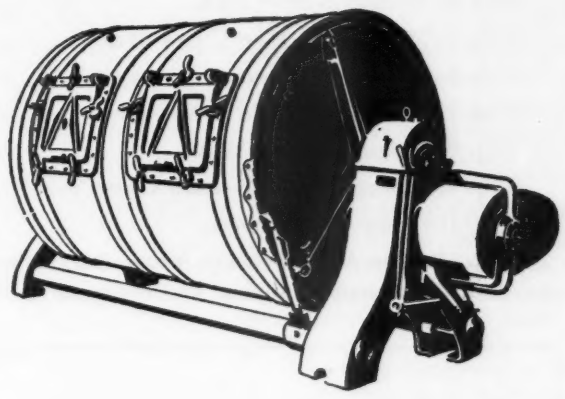
quite different from the 150 kilocycle pass band ordinarily used. Commercial experiments conducted ten years ago failed because they used receivers of conventional bandwidth. Due to these early failures, further research was for a long time discouraged.



The tube is the mercury delay column used in the laboratory tests. In front of it appears part of the F-M receiver.

A receiver utilizing the four megacycle pass band was built, and was tested with the laboratory setup previously described. Results showed that the theory involved was substantially correct. The receiver was subjected to two out-of-phase waves, and there was no noticeable distortion except when the voltages produced by each of these waves were nearly equal. Even in the worst possible case, where the strengths of the two component signals did equal each other, the results obtained were superior to those of A. M. transmissions. A field test, where the equipment will be used to receive trans-Atlantic broadcasts, is planned.

Another page for **YOUR BEARING NOTEBOOK**



How to turn a churn of butter better

Engineers who design creamery equipment have found that a sure way to keep a churn turning smoothly, quietly and steadily is to equip all journals and countershafts with Timken tapered roller bearings.

Because Timken bearings have true rolling motion and take both radial and thrust loads in any combination, the churn drive operates with less power, less wear, less maintenance. And with Timken bearings, more effective closures are possible, keeping lubricant *in* and dirt *out*.

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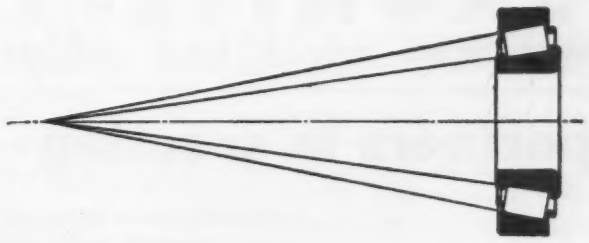
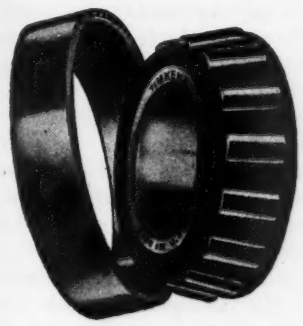
The rollers in Timken bearings really *roll*. That's because rollers and races are precisely tapered so that all lines coincident with their tapered surfaces always meet at a common point on the axis of the bearing.

This means friction-free operation, minimum wear, greater precision. It's another reason why 9 out of 10 bearing applications can be handled more efficiently with Timken bearings.





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TAPERED ROLLER BEARINGS

Would you like to know more about bearings?

Some of the important engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'd be glad to help. For additional information about Timken bearings and how engineers use them, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL ◐ AND THRUST ⊣○⊢ LOADS OR ANY COMBINATION ✳

AN OKONITE "TWIST" ON CABLE TESTING

Okonite research includes subjecting short lengths of electrical cable to torsion tests (pictured above), twisting them through a spiral arc of 180° under a heavy load.

Bending tests, impact tests, tests of wear-resistance by abrasion — these are a few of the mechanical tests which, along with electrical, chemical and weather-exposure tests, complete an integrated program of performance checks. From its results comes information which Okonite engineers translate again and again into wire and cable improvements that mark major advances in the field. The Okonite Company, Passaic, New Jersey.

5171

OKONITE SINCE 1878

insulated wires and cables

can you do it?

Solution:

Here is our solution (others are possible):

Trip 1: Man A and Woman A row over.

Trip 2: Man A rows back.

Trip 3: Woman B and Woman C row over.

Trip 4: Woman A rows back.

Trip 5: Man B and Man C row over.

Trip 6: Man B and Woman B row back.

Trip 7: Man A and Man B row over.

Trip 8: Woman C rows back.

Trip 9: Woman B and Woman C row over.

Trip 10: Man A rows back.

Trip 11: Man A and Woman A row over, completing the task. Everyone is across, and everyone is happy.

briefing the news

(*Continued from page 355*)

new "gun," when directed at its target, sucks in a stream of air. Sensitive to certain types of gas and vapor, such as freon, the instrument is used for locating extremely small leaks in pressure systems. It will detect freon leakage, for example, at as low a rate of loss as one-hundredth of an ounce a year.

The device will detect compounds only of the halogen family, according to Mr. White. Vapors of carbon tetrachloride, chloroform, methyl chloride, methyl bromide, and hydrochloric acid — among others — have been detected experimentally in amounts as small as 10 parts per 1,000,000 parts of air. The instrument is also sensitive to cigarette smoke.

Compact and portable, the detector unit weighs only two and one-half pounds, and its control unit 15 pounds. Whereas in the conventional electronic tube, negatively-charged electrons stream from the heated cathode to the positively-charged anode, this instrument operates on the contrary principle that when a suitable metal surface is operated in air at red heat, it emits positive ions. These pass through the air from a hot anode to a cold cathode. When certain elements or compounds, notably the halogens, strike the hot anode, there is an increase of current as a result of an increased positive emission.

The primary application for this electronic instrument is as a detector of extremely small leaks in tanks, boilers, piping, and other closed systems into which halogen compounds can be introduced as a tracer.

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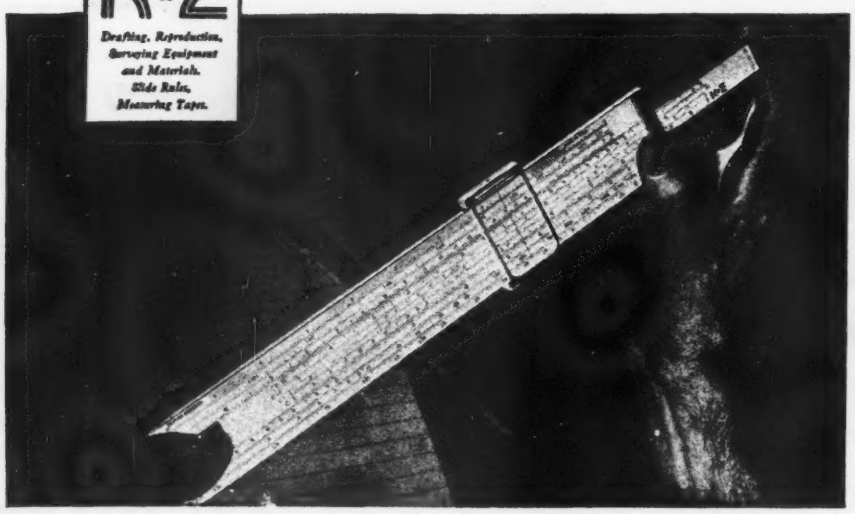

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briefing the news

Growing New Metals . . .

Chemists at the University of Virginia are "growing" new metals — varieties of copper, zinc, and aluminum with differing crystalline structure that cause them to be as unlike their prototypes as if they were new chemical elements. The project was a secret one during the war and was under the direction of Dr. Allan T. Gwathmay of the Cobb Chemical Laboratories; it is now an open one, however, and first news releases indicate that these new metals differ enormously from their originals as regards their reactions to friction, corrosion, oxidation, and wetting.

The work has involved the production of super-crystals millions of times larger than old metal crystals, Dr. Gwathmay says. These crystals are grown from the molten metals and then either machined into spheres or are cut so as to give flat faces as much as one inch across. A special polish making it possible to detect small changes on the surface is applied, and, finally, chemical reactions of all sorts are studied. Because the chemistry of a substance is, among other things, dependent upon the distance between the atoms, and because each crystalline structure presents a different pattern of atom spacing, every surface reacts in its own way to the same process.

This development is expected to be of particular importance in the field of industrial catalysis, where mixtures of gases are exposed to metal surfaces to speed up reactions among the vapors. If it were possible to find the proper highly reactive metal surface, industry could accelerate its production of synthetic fuel and rubber, aviation gasoline, explosives, plastics, and fertilizers.

The project was originally started to determine a method of reducing wear and friction in aircraft engines, it being realized that parts would last many times longer if the metal surfaces consisted of only the most wear-resistant sides of the crystals.

Titanium . . .

The new wonder metal of the atomic age will be titanium, predicted Atomic Energy Commissioner Sumner T. Pike recently. It is the fourth most abundant element in the earth's crust, is as strong as steel though only of one half the weight, and is up till the present by far the most promising material for "kettles" of atomic energy. And, although its extraction from native ores has baffled science for some time, the Bureau of Mines is now producing it in 100-pound lots.

"Nobody acquainted with the problem of atomic fission," Pike says, "has any reasonable hope of getting power in any other way than by first reducing released energy to heat, as in the case of conventional fuels. But the heat will have to be of a considerably higher order than the levels we are accustomed to in ordinary power production. Levels of 1,800 to 2,700 degrees Fahrenheit seem to be about the range to shoot for. Thus the question immediately arises as to whether steel can stand up at such ranges.

"Success in building new power reactors calls for a metal of structural strength equal to or better than that of steel and also able to stand considerably higher temperatures. The metal must not absorb too many neutrons and thus slow down the reaction, and it should be one that could eventually be produced at reasonably low cost.

"A glance at the periodic table of elements in nature shows titanium as a possible candidate. It has a strength-weight ratio considerably better than good structural steel. It seems to stand up under high temperatures very well indeed. Also, let us say, for the sake of the argument, that it has a very low neutron absorption coefficient.

"As a pure metal, titanium hardly exists at all. It is in about the same state that aluminum was eighty or ninety years ago. If it turns out to have the qualities we want, there is no immediate obvious reason why it cannot be produced in large quantities and at quite low cost per pound."

So far, the lowest price at which science has been able to produce titanium is $.50 per pound, but it is expected that this price will be greatly reduced with large scale production. Titanium has also been widely considered as the material for jet planes and even destroyers and cruisers.

Leak Detector . . .

An electronic instrument which looks like a pistol, and which rather than puncture a "target" detects possible leaks in it, has been developed by the General Electric Research Laboratory under the direction of W. C. White, chief electronics engineer. Instead of firing projectiles, the

(*Continued on page 356*)

Careers at GENERAL ELECTRIC

ENGINEER...PHYSICIST...CHEMIST

For each, General Electric has assignments to his liking

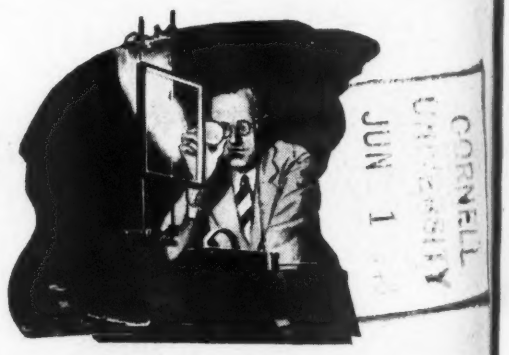
General Electric is not one business, but an organization of many businesses, ranging from the building of transformers at Pittsfield, Mass., to the molding of plastics at Anaheim, Cal. Graduates of American colleges and universities are finding that the 125 plants of General Electric offer opportunities to all degrees of specialists, all sorts of enthusiasms, all kinds of careers.

ENGINEER

Quoting Harry Winne (Syracuse '10), vice president in charge of engineering policy: "The expansion of General Electric into new fields and into production of more highly complex equipment is building an unprecedented need for exceptionally trained engineers . . . To help meet this demand, the Company is steadily expanding its Advanced Engineering Program, under which young G-E engineers can study deeply into such highly specialized fields as fluid mechanics, electronics, and electro-mechanical engineering."

PHYSICIST

"Industry is finding need for physicists in fields considered to be foreign to them ten years ago"—that is the prospect outlined by Dr. C. G. Suits (Wisconsin '27), vice president and director of the G-E Research Laboratory at Schenectady. Optical studies, high-energy nuclear research, "superconductivity," magnetic properties, high-frequency currents, physical metallurgy—these are but a few phases of the work now being done in physics by General Electric.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INSULATION CHEMIST

While much of General Electric's research in—and *careers* in—chemistry centers in the Chemical Department, numerous chemical projects are carried on by other of the Company's divisions. At Bridgeport, Conn., Lyman H. Hitchcock (Connecticut, '26) heads up development of such special insulations as Butyl rubber and Polyethylene. The Company is a leader in the development and application of both of these synthetics for insulation purposes.

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